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A view of journey of chick development from day one of the embryo till hatching, describing the organs formed with their respective days of development

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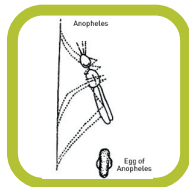
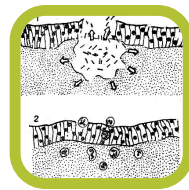
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## EDITORIAL

Life sciences comprise the field of science that involves the scientific study of living organisms such as micro organisms, plants, animals and human beings as well as related bioethics. In the present issue, third in the series on the completion of 50 years, we have included articles from various disciplines of life sciences.

The articles "Psychotropic Drugs I" and "Psychotropic Drugs II" discuss about some of the natural drugs like opium, cannabis, coca, etc., obtained from plants, in the first article, and describe various synthetic drugs like L.S.D. sedatives, tranquillizers and their effects on addicted people in the second article and describe them as chemical which affect physically and modify mental activity of human. Addiction to such drugs means a compulsion on the part of the user to continue the use of drugs. The articles give the message that the addicted society needs to be cured, and addicts are terribly lonely people, we should not reject them.

In the paper "Plants and Human History" the researcher connects the plants with their utility to humans and describes the quest for spice, oils and opium in the world history, discussing plants like sugarcane and sugar beet, cotton, potato with their associated problems like blights, rusts and mildews.

"The Unborn One" is a beautiful article in which the author in a very interesting way explains the journey of chick development from day one of

the embryo till hatching, describing the organs formed with their respective days of development.

In the paper "Fauna of Our Oceans" the researcher deliberates on the distribution of great variety of animals from minute unicellular protozoa to the most highly evolved mammals in the littoral zone of the sea shore.

The article "New Light on the Spread of Leprosy" discusses that multi-disciplinary studies provide very strong evidence in support of the nose as the primary site by which leprosy bacilli are discharged to the exterior and thus the importance of the nose in transmission of the disease.

In the article "Cancer: Environmental and Habit-linked Causes", the researcher discusses about the cancer and its causes and how chances of falling victim to one or other form of cancer be minimized, if we cultivate desirable personal and social habits.

In the paper "A Goddess Defied" the author argues that the vaccinators would have to jab themselves in front of the entire community, to prove that there was nothing harmful.

In "Bose and Raman's Ways in the Classroom : Demonstrating the Death of Plant Cell and Magnets" the researcher talks about the living cells which have specific structural organization and heating beyond a limit (pasteurization) destroys that organization causing their death.

"Fight Against Malaria and Ronald Ross" sheds light on one of the biggest killer diseases

i.e. malaria and its symptoms, cause, parasite and its carrier i.e. female anopheles. The article also gives a brief on Ronald Ross who was awarded Nobel prize in 1902, for his work on malaria.

In the paper "The Concept of Ultra-dimension and Thermodynamics for Young Cell Biologists" the author attempts to show the way to teachers and students as to how to absorb and assimilate some hard concepts like free energy, entropy, enthalpy and total energy and discusses the necessity of thermodynamics and ultra dimensions in the field of biology.

The paper "The Water Decade" highlights concerns on safe drinking water and sanitation. It does not directly concern water management.

In the paper "'Hear' it Loud and Clear" the researcher discusses some of the common ear problems which hinder hearing including ear discharge, ageing, antibiotics, tinnitus and vertigo, with their respective treatments.

In article "Why Animal Dissection in the School?" the researcher discusses a number of cases for and against the dissection, and he concludes that dissection offers the opportunity to combine cognitive knowledge and psychomotor skills.

In "The Fascinating Journey of Chromatography" the researcher explained the different types of chromatography (i.e. separation technique) and their applications for separating biological cells, sub cellular particles, viruses, protein aggregates, fly ash, colloids and pigments.

In "Living with Arthritis" the author describes some of the common types of disease i.e. osteoarthritis and rheumatoid arthritis found in population and discusses their symptoms and diagnostic techniques including radiation synovectomy.

We sincerely hope that our readers would find the issue interesting and educative. Your valuable suggestions, observations and comments are always a source of inspiration which guide us to bring further improvement in the quality of the Journal.

# PLANTS AND HUMAN HISTORY

## P. Maheshwari

University of Delhi

There is often an impression in the mind of the layman that the study of botany is an innocent pastime peculiarly suited to the female sex because of the nice colours, elegance, and fragrance of flowers and plant parts. They do not soil their nice dresses, nor give out the foul smells characteristic of a laboratory dealing with animals. There is also not much danger of burning the hands, or of having to exert the brain with difficult mathematical problems as in physics and chemistry.

All of these premises are false as botanists will no doubt appreciate and understand at once. As I shall try to show, for obtaining plants men have gone forth with the sword to distant lands, set upon long voyages of discovery, and conquered new lands. In fact, even in the modern world, plant power means as much or more than water power, sea power, atomic energy, and so on.

### Quest for Spices

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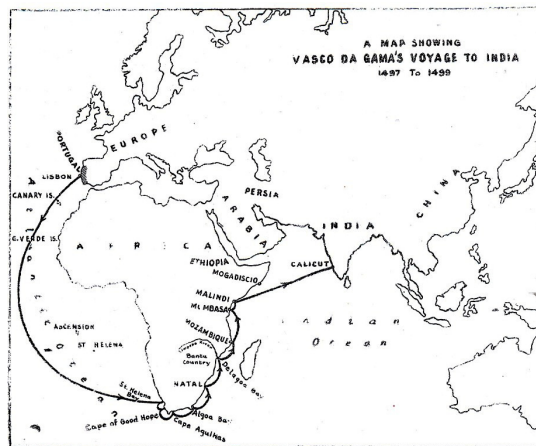
Of considerable significance in this connection are the spices. Common-place though they are today, the history of their cultivation and transport is a romance which includes accounts of geographical discovery, economic warfare, annexations of territories, and all the vices of theft, envy, hatred,

and subterfuge which the human species is capable of.

There was a period in history when India was a prosperous country, flowing with 'milk and honey'. The economy of the people was sound and from the evidence of foreign visitors like Megasthenes it appears that famines never occurred those days. Of its plant resources, pepper (*Piper nigrum*) was among the most important from the international point of view. Two thousand years ago only kings and the wealthiest nobility could afford its use. In Rome during the first centuries of the Christian era it was measured out in balances for its equivalent weight in gold. In 408 A.D. when Alaric the Goth captured Rome and massacred many of its citizens, he demanded as his tribute 5,000 lb. of gold, 3,000 lb. of pepper and 30,000 lb. of silver. Attila (406-453 A.D.), King of the Huns and Scourge of God, as he was called, demanded 3,000 lb. of pepper as part ransom for the city of Rome. In medieval Europe pepper was held in such high regard that landlords readily accepted rents in pepper. It ranked as a commodity of standard value just as tobacco was legal tender in colonial Virginia. Kings presented pepper to each other and it was received most cordially. Hermann (1958) in his book, *The Great Age of Discovery*

writes: 'Custom duties, rents and taxes, even court fines were paid in pepper. It bought ground and land, paid off mortgages, could buy burghership and coats of arms. The most beautiful women, the noblest horses, the most brilliant jewels, precious carpets, rare furs: all these could be had for pepper.' Many other spices were also held in high regard. A single pound of ginger could buy a sheep, and a pound of cloves could buy seven sheep. In Rome, on special occasions, the streets were 'fumigated' with cloves; and it was the custom in China to hold a clove in the mouth if anyone wanted to speak to the Son of Heaven.

At first it was the Persians who took spices from India by caravans and sold them to the Phoenicians of Sidon and Tyre who traded in them all along the Mediterranean coasts from Alexandria to Rome. From the first to the eighth century Indian and Greek traders held the monopoly. Later, the Arabs took up the trade and sold the spices to Venetian traders in the markets of Damascus, Istanbul and Beirut. Arab sailors ventured far out to the East into Ceylon and the Moluccas. The Venetians of those days spoke of the 'spices of Araby' knowing little about their real origin. Later Malacca and Malabar were considered to be the homes of cloves and nutmeg, when in reality they came from farther east and India was only the wholesale shipping agent for some of these products. The Arabs closely kept the secret and obscured their account with tales of terrible sea-monsters and wild animals which not even the bravest of the Venetians dared to see for himself.



**Fig. 1: Map showing route taken by Vasco da Gama for going from Lisbon to Calicut**

It was not until Marco Polo (1254-1324?), a boy of 15 years, went with his father and uncle to China, and brought with him an account of the treasures of the Orient (the ginger and camphor of China, cloves and nutmeg of the Pacific islands, cinnamon groves of Ceylon and the pepper vines of Malabar) that the Europeans began to have some idea of oriental geography and the spice treasures of the East. The prosperity of Venice, resulting from her trade with India, was a matter of extreme jealousy to the other European powers who were anxious to get direct to India without the intervention of Venice or Egypt. Columbus (1451-1506) sailed westward but discovered America instead of India. Inspired by Prince Henry the Navigator (1394-1460)<sup>1</sup> the Portuguese sailors were at the same time pushing farther and farther down the coast of Africa. In 1497 Vasco da Gama (1460-1524) rounded the Cape of Good Hope (formerly called the Cape of Storms) and then

1. Henry himself navigated no ships and never went beyond the straits of Gibraltar, but he greatly promoted maritime exploration and was keen to find an all sea route to India with the object of circumventing the Red Sea route which was under the control of the Arabs and the Egyptians.

reached Mozambique in March 1498. His ships reached Malindi at the end of April. Guided from there by a Gujarati pilot he landed a few miles north of Calicut on May 17, 1498, after a strenuous voyage of nearly 11 months in which more than half of his men died of scurvy (see Fig. 1 for route followed by Vasco da Gama). The importance of Vasco da Gama's discovery lay in that it broke the monopoly which the Egyptians and Venetians held for several hundred years in the trade with India. Very soon the Portuguese came into conflict with the Arabs whom they ousted from the Indian shores, and later with the Indian princes who were silenced by gunfire. Encouraged by their successes and the superiority of their arms the Portuguese seized the coastal areas of Ceylon with its great cinnamon forests and founded 'a brave little empire over half a year's journey from the homeland.' They made a law—the disobedience of which was punishable by death—that no native could cut a single foot of cinnamon bark or sell it except under the orders of the conquerors. On the Malabar coast they captured Goa and built a large warehouse and fort. Among the articles they took from India, were pepper, cardamom, cinnamon, ginger and coir for making ropes for their ships. Portugal was then at the zenith of her power. She was mistress of the seas and the maritime capital of Europe. On the western side she had discovered Brazil; on the eastern side she went further, seized Malacca, key city of the Indian seas; and then the Moluccas or Spice Islands. As Peattie says in his fascinating book entitled, *Cargoes and Harvests*, 'Great was the wealth of the Portuguese East India Company and exorbitant the profits it reaped. With slaves to gather the precious spices, without a rival in the

Indian seas, the company poured into the lap of Lisbon such wealth as that old city had never dreamed of'.

However, the small country was not able to hold its far-flung possessions for a long time. The Dutch and the British mercilessly attacked its fleets everywhere and in 1581 the Portuguese crown was united with that of Spain. The Spaniards preferred the Atlantic and the rubies and gold plundered from the Aztecs and the Incas than the spices of the Orient.

In 1594 the leading merchants of Holland held a meeting at Amsterdam and decided to send a Dutch fleet to India. A company was formed and a fleet of 4 ships left for India in 1595. In 1599 the Dutch had already established an eastern trade and then came the British. Like ants following a cube of sugar, the Dutch sailor trailed around the Cape of Good Hope to India, and then went on to Malacca and finally to the Spice Islands. One by one the Portuguese possessions fell. As Panikkar (1929) says: 'Challenged on the sea both by the Dutch and the English and hated by the Indian powers, the Portuguese fought a losing battle'.

Ruthless and inhuman in their relations with the native inhabitants, the Dutch did the job even more thoroughly than the Portuguese. Wealth poured into their little country as it had done before into Portugal. Large and beautiful buildings were erected, fashionably dressed men and women paraded the streets, men lived in ease and idleness and 'there sprang up in Holland a galaxy of painters, musicians, scientists and poets'. Persia, Phoenicia, Arabia, Damascus, Venice, Lisbon and now Amsterdam flourished by turns under the Midas touch of spices.

Holland's genius burned for a century. Other European nations were jealous, and in 1770 Poivre, the French Governor of Mauritius, smuggled cloves and nutmeg out of Moluccas to his own province. From there the plants were taken to Zanzibar and the West Indies. The Dutch monopoly was broken, although they continued in Indonesia until 1947 and still made great profits in various ways.

The British were at first friendly to the Dutch but after the Portuguese were put out of action, they changed sides and for many years there were naval and land clashes between the British and the Dutch. In 1786 the British got a grip on Penang, then on Singapore and later on Hongkong. The British East India Company conquered almost the whole of India which passed on to the British Crown in 1857 and remained a part of the British Empire until 1947.

## **Mutiny on the Bounty**

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Many people have heard of Captain Bligh's voyage to the island of Tahiti and the rebellion of the crew of his ship *Bounty*. This has figured in several novels and even a cinema film has been made of it. Not all know the object of Bligh's expedition, however. In the 18th century the British planters in the West Indies had devoted large areas to the growing of sugarcane. For their slaves it was necessary to have some cheap food and the planters thought that they had found an answer in the breadfruit (*Artocarpus incisa*), news of which had been brought to England by various south sea explorers including Captain Cook. Like the jackfruit, this is a large tree and the fruits grow on boughs like apples. When ripe they are yellow and soft with a pleasant taste. Being in

season for eight months in the year, the tree formed an important food for the natives in the South Pacific islands. The planters of the West Indies were attracted. Sir Joseph Banks, then President of the Royal Society and himself a botanist, persuaded King George III to charter a ship under Captain Bligh who had once accompanied Cook and took a keen interest in natural history. Two horticulturists of the Kew Gardens were sent with him to tend the plants on the return journey. The *Bounty* sailed from England on October 15, 1788. Due to wind and currents she failed to round Cape Horn and had to be turned eastward reaching the Cape of Good Hope on May 22. From there it went to Tasmania and it was only on October 24, 1788, after a full year, that it reached Tahiti. Bligh gave to the natives the seeds of melon, cucumber, some stone fruits and almonds, and took from them young plants of the breadfruit. On April 4, 1789, five months after its arrival at Tahiti, the *Bounty* set off for the West Indies. However, the sailors had taken native wives and begun to enjoy life on the island. They were most unwilling to return. Bligh's treatment of his men had been rather high-handed and he used to award stern punishments for comparatively small offences. This had caused resentment in the minds of many. At the same time it appears that he had not chosen his crew carefully. A good proportion of them were an irresponsible lot who preferred a life of ease and luxury rather than face the danger of the sea. On April 28 the bubble burst and the famous mutiny broke out. The rebels threw the precious cargo overboard and in a few hours the breadfruits were floating in the Pacific. Turned out by the mutineers alone Bligh, along with a score of loyal followers, performed a voyage miles in an open boat. This has become one of the epics of the sea (Fig. 2).

In October 1790, the mutineers were court-martialled; and in December, 1792, Bligh started on a second breadfruit voyage. His ship, *Providence*, arrived at Tahiti on 8 April 1793. On July 18, it left with 2,126 potted breadfruit trees and about 590 other plants. Only a fraction of these survived and could be delivered in the islands of the West Indies. Bligh was made a Fellow of the Royal Society in 1801 in consideration of his distinguished services to navigation and botany and later promoted to the rank of Vice-admiral. Although the breadfruits thrived in their

South Seas, it forms a basic part of the diet of the people of West Indies.

George Mackaness, biographer of Bligh, concludes that while at one moment he 'could abuse an officer roundly, in language hot and stinging' at the next, his anger cooling as rapidly as it boiled, he would invite the offender to supper with him. He never spared himself in the discharge of his duties, possessed unimpeachable integrity, and had a mind capable of providing its own resources in difficulties. His chief fault was

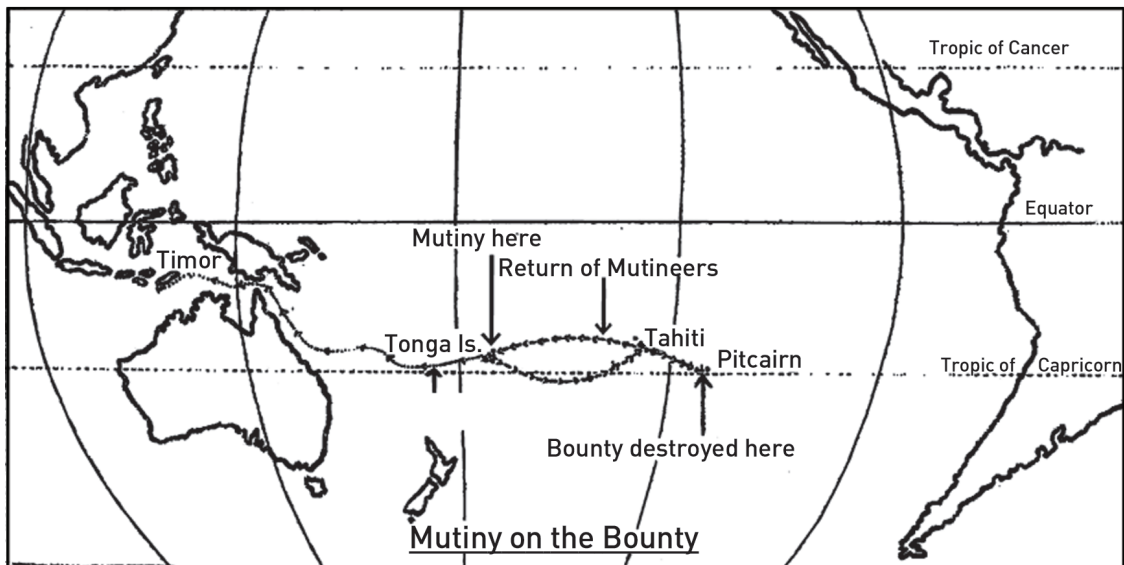


Fig. 2: Map to show part of the route followed by Bligh on his return journey from the Tahiti Islands. The mutineers left him in an open boat and returned to Tahiti. From there the *Bounty* was taken to the Pitcairn Islands and destroyed there.

new setting, the planters' dreams remained unfulfilled for the negro slaves did not relish them.

However, now it has undergone a revival in the West Indies. Although not so popular as in the

an absence of tact and a failure to realise that wounds caused by the sword may heal but those caused by a sharp tongue are remembered forever.



## Essential Oils

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References to Sanskrit literature, including *Ramayana* and *Mahabharata*, show that the distillation of essential oils and the preparation of perfumes, was one of the most ancient crafts of India and in past she had the leading position in perfumery. In Mughal times the Emperor Babar (1483-1530 A.D.) was very fond of roses and we read in the *Ain-i-Akbari* that he always encouraged the art of preparing perfumes and scented oils. The Empress Noor Jehan used to bathe in water scented with roses. For many years Indian perfumes were the rage in foreign lands. Queen Elizabeth (1533-1603 A.D.) as well as Mary, Queen of Scots (1542-1587 A.D.) extravagantly used Indian perfumes. At the French Court of Versailles, the King himself supervised the proper blending of essences for the royal bath, for which there was designed a different formula for each day of the year. In banquet halls it was not uncommon to have perfumed doves fluttering about so as to fill the room with aroma (Fig. 3), and slave girls used to comfort guests with scented fans. Nobles used to have the horses drawing their coaches anointed with perfumed oils so that the backward breeze brought an aroma to them.

In the 18th century the export of Indian perfumes to England went up to such an extent that the British Parliament took the matter rather seriously. Very likely quite a few of its members had discovered to their chagrin that the lovely creatures whom they had wedded were not all they had seemed, and every night each of them shed a good part of her beauty much as a caterpillar sheds its skin. The following Act passed by the Parliament in 1770 speaks for itself:

‘That women of whatever age, rank, profession or degree, whether virgins, maids or widows that shall, form and after such act, impose upon, seduce and betray into matrimony, any of his Majesty’s subjects by the scent paints and other such artificial means shall incur the penalty of the law in force against witchcraft and like misdemeanours and that the marriage upon conviction shall stand null and void.’



**Fig. 3:** Scene showing a royal banquet with perfumed doves fluttering in the hall. Indian perfumes were exported in large quantities to Europe during the middle ages.

## Sugarcane and Sugarbeet

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It is generally agreed that South-east Asia, more especially India, is the original home of the sugarcane. According to Hindu mythology, Vishwamitra is said to have created the plant in the temporary paradise of King Trishanku, and it became available to the inhabitants of this earth only after the destruction of that paradise. According to some it is the bow of Kamadeva, the God of love. The word *Ikshu* occurs in the *Atharva Veda* (1,000 B.C.) and some royal families used the

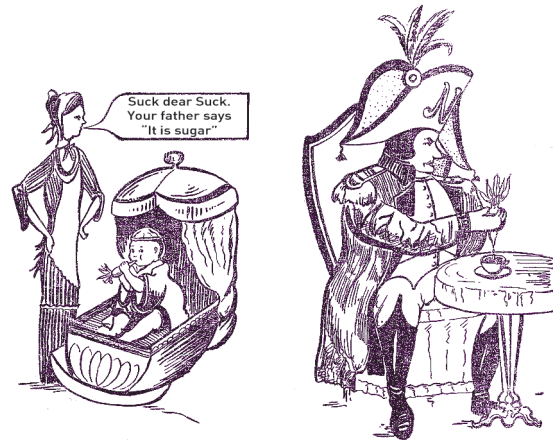


epithet 'Ikshwaku'. Alexander and his soldiers were perhaps the first Europeans to see sugarcane and wrote back to their friends in Greece that the barbarians across the Indus grew a reed from which they obtained all the honey they wanted. In the 5th century A.D., cane cultivation spread to Iran, and in the 7th century to Egypt and Spain. By the 16th century it had extended even to the New World which had been found by Columbus.

Now-a-days we are selling and buying of sugar as an ordinary thing, but for centuries the only sweetening material known to Europeans was honey. When Indian sugar first became available to the West, it was a prized commodity. Nations contrived, struggled, plotted, and fought for trade supremacy in it.

In 1747 a German scientist, Marggraf, noted the presence of sugar in the roots of the beet but no serious notice was taken of this discovery except in Germany. During the days of Napoleon, the relations between England and France were strained for a long period. While Napoleon ruled the land, the British Navy had command of the seas. The cessation of maritime trade had a paralysing effect upon the sugar refineries of Europe which had been importing raw sugar for many years and selling the finished product to Germany, France and other countries. Everywhere there was dearth of sugar. On March 25, 1811, Napoleon issued a decree subsidising the establishment of the beet sugar industry. The beet was launched as a new crop in France. The British ridiculed the whole idea and published cartoons in their newspapers. One showed the great Napoleon sitting at coffee and squeezing a big beet root in his cup. In another (Fig. 4) a nurse had thrust the thin end of the root into the mouth of

Napoleon's little son, the King of Rome, and was saying "Suce moncheri, suce, ton pere dit que c'est due sucre" [Suck, my dear, suck, your father says it is sugar].



The nurse to Napoleon's son.  
The king of Rome : Suck dear suck.  
Your father says, "It is sugar".

The Great Napoleon  
squeezing a beet root to  
sweeten his cup of coffee.

**Fig. 4: Two old but famous cartoons showing how the British ridiculed Napoleon's idea of obtaining sugar from beet root.**

The encouragement, which King Frederick of Germany and Napoleon gave to the beet, together with the work of selection and breeding, undertaken by botanists, has made it one of the most important crops of modern times. A mediocre in productivity has been transformed into one of the greatest of our agricultural crops through the joint efforts of kings and scientists.

## The Opium War

Opium was exported from India to China even in the 15th century, but this trade was responsible many years later for a war followed by serious

consequences. After the sea-route to the East had been opened and the British had occupied parts of India, they tried to extend their influence to China. However, there was some difficulty about the ceremonial to be observed, and in 1793 the Chinese Emperor refused to see the British envoy. The ceremony to be performed was called the 'kotow', which is a kind of prostration on the ground. In reply to the British King's request for trade facilities, the Chinese emperor simply answered: "We possess all things and have no use for your country's manufactures."

However, the East India Company, ever ready for profits, continued to take a keen interest in exporting opium partly as a method of payment for silk and tea which they purchased from China. The Dutch in the East used to mix it with their tobacco and then smoke it as a preventive against malaria. The Chinese had gone one step further and used to smoke pure opium. The Chinese Government wanted to stop the habit because of its bad effect on the people, and also because the opium trade took away a lot of money from the country. However, it had little success.

In 1800 the Chinese Government issued an edict prohibiting all imports of opium. Unwilling to lose its profits, the East India Company persisted with the smuggling of opium into the country and bribed Chinese officials to overlook this. In 1834 matters became worse as the British Government put an end to the monopoly of the East India Company in the China trade, and threw it open to all British merchants.

There was a sudden increase in opium-smuggling, and the Chinese Government at last decided to take strong action. In 1839 they appointed one, Lin Tse-hsu, as special

Commissioner to suppress the smuggling. He acted promptly. He went personally to Canton in the south, which was the chief centre for this illegal trade, and ordered the foreign merchants there to deliver to him their entire stock of opium. Since they refused to obey, Lin cut them off in their factories, made their Chinese workers and servants leave them, and allowed no food to go to them from outside. This vigour and thoroughness resulted in the seizure of 20,000 chests of opium. Lin destroyed all of them and told the foreign merchants that no ship would be allowed to bring opium to Canton. If this promise was broken, he threatened to confiscate the ship and its entire cargo. Lin played his part well, but did not foresee the effect of his policy.

In the name of national honour and for the right of forcing opium on China, Britain declared war on the country in 1840. China could do little against the British fleet which blockaded Canton and other places. After two years she was forced to submit, and in 1842 the Treaty of Nanking laid down that five ports were to be opened to foreign trade which at that time meant especially the opium trade. These five ports were Canton, Shanghai, Amoy, Ningpo, and Foochow. They were called the 'Treaty Ports' in which British merchants had the right to 'reside and carry on trade'. Britain also took possession of the island of Hongkong, near Canton and extorted a large sum of money as compensation for the opium that had been destroyed, and for the costs of the war which she had forced on China.

The Chinese Emperor made a personal appeal to Queen Victoria, pointing out with all courtesy the terrible effects of the opium trade which had been forced on China. There was no reply from the Queen.

Only fifty years earlier his predecessor, Chien Lung, had refused to meet the British envoy.

## Potato

The potato is one of the most important food crops of the world. Believed to have originated in Peru and Bolivia, it was introduced into Spain in 1570 soon after the discovery of America. About 1586-1588 it was taken to Ireland by Sir Walter Raleigh. The French gave it the name 'pomme de terre' or apple of the earth. There was a lot of opposition in Europe to potato in the 16th and 17th centuries and most persons held it at an arm's length. Some said it caused leprosy; others said it gave rise to scrofula, rickets and tuberculosis. Still others denounced it on the ground that it was not mentioned in the Bible. The credit for promoting potato culture in Prussia goes to Frederick the Great. In 1744 he caused seed potatoes to be distributed free and compelled the peasants to cultivate them under threats of cutting off their noses and ears. The scarcity of food, caused by the Seven Years' War gave much encouragement to the industry. However, even as late as 1774 the hungry people of Prussia rejected a load sent by Frederick the Great: "The things have neither smell nor taste, not even the dogs will eat them, so what use are they to us?" England was not far behind in such nonsense and one man standing for election to the Parliament used the slogan: 'No potatoes, no Popery'. Potato was regarded as the badge of servility, utterly unfit for free men and specially Englishmen. Many farmers fed potatoes even to pigs and horses with great reluctance lest they may poison the poor animals.

The introduction of potatoes into France was largely due to Antoine Auguste Parmentier who, while a prisoner in Germany during the Seven Years' War, was fed upon potatoes and had learned to like them. Parmentier planted them on a piece of land obtained from Louis XVI (1754-1793). This was at first a sandy waste but the potatoes turned it into a blooming garden. A military guard in full uniform was stationed near the field during the day (Fig. 5) but was withdrawn at night, whereupon a number of people came



Potato field near paris, guarded by soldiers

Fig. 5: When potato was introduced into France in the 18th century no one liked it. A Frenchman, named Parmentier, planted a field near the King's palace. The field had military guard in daytime to arouse the curiosity of the people as to the kind of food that was being grown for the king.

secretly to steal the tubers (Fig. 6). They ate them with relish and planted them in their own gardens—the very object which Parmentier had in view.



**Fig. 6:** In the night the guard was removed, and plenty of men and women went with picks and shovels to collect the potato tubers.

At one time, when his plants were in full bloom, Parmentier presented a bouquet of the flowers to the King who placed one in his buttonhole and gave the rest to his Queen, Marie Antoinette (1755-1793). She appeared in the evening wearing them in her hair. All the court tried to imitate their example. When Parmentier died, potatoes were planted on his grave. In England too it was the peers who first ate potatoes and the common people followed. Hot baked potatoes soon began to be hawked by vendors in London streets. It

was, however, in Ireland that the potato was especially popular and became the staple food of the people.

In 1778 there was a war between Germany and Austria which is commonly known as the Potato War or 'Kartoffel Krieg'. Frederick the Great invaded Bohemia, and the Austrian army and his own faced each other on the Elbe near Koniggratz. Partly because of shortage of supplies and partly because of the strength of the Austrian position, Frederick realised that the campaign, as he had conceived it, was not likely to succeed. 'Both the Prussian and the Austrian armies thenceforth confined themselves to the 'potato-war', -that is, they consumed the resources of the enemy's country, till the cold weather set in and forced them to terminate their inglorious campaign by evacuating Bohemia'. (*Cambridge Modern History*, vol. 6: 706, 1909).

In Cromwell's campaign against Ireland, the potato played a different part. After subduing the chief urban centres, the invader wanted to punish and overawe the peasants by sending harassing bands to villages. Here the potato proved a source of great strength to the Irish, for the underground crop still remained intact when overland crops were open to destruction and loot by the soldiers.

## **Blights, Rusts and Mildews**

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As already mentioned the potato enjoyed special popularity and became the staple food of the Irish people. However, this dependence on a single crop later became the cause of great trouble and suffering. There was a terrible failure of the crop in 1845 and again in 1846. Father Mathew, a Catholic priest wrote: On the 27th of the last



month (July 1846) I passed from Cork to Dublin, and this doomed plant bloomed in all luxuriance of an abundant harvest. Returning on the third instant (August) I beheld with sorrow one wide waste of petrifying vegetation. In many places the wretched people were seated on the fences of their decaying gardens, wringing their hands, and wailing bitterly the destruction that had left them foodless.

Nobody knew the real reason for the failure of the crop. Many believed it to be a scourge from God to punish the sins of the people. One writer said that the trouble was due to volcanic action within the earth. Other blamed the weather. Lindley, the editor of the *Gardener's Chronicle* of London, who examined the infected leaves under the microscope, considered the fungus to be an excrescence from diseased tissue and not the cause of it. The price of ignorance was terrible. "With startling rapidity, shortage passed to famine, famine to starvation, and starvation to death, which, if it brought peace to its elect, augmented the suffering of those it spared." (Salaman, 1949).

In their helplessness many of the Irish people immigrated to the United States. As Salaman says in his book on the *Origin of the Potato* the emigrants carried with them 'into their new life overseas an inverted love of their old home, in the form of a deep anger and a bitter hatred of England, to whom they ascribed not only the old historic grievances, but the cruel misfortunes which had overtaken them in consequence of the potato famine'.

To mention another example, at one time coffee cultivation was to Ceylon what maize is to North U.S.A. or wheat is to the Punjab. The little island

had taken to this crop with great enthusiasm and was making good profits through it. In 1869 M. J. Berkeley described a pretty microscopic fungus on some coffee leaves received from the Botanical Gardens at Peradeniya and named it *Hemileia*. At that time neither the planters nor the Ceylon Government bothered, but within the next 10 years the disease spread over the whole island. The fungus did not kill the host outright but there was a frequent shedding of the leaves so that the productive capacity of the plants was reduced to less than half. The Ceylon Government now woke up and wrote to England for help. In 1880 the authorities at Kew recommended to them the services of H. Marshall Ward. He made a thorough study both in the field and the laboratory but it was already too late to save the coffee. The productivity of the trees continued to go down. It was a losing battle and coffee cultivation no longer remained profitable. Ruined and discouraged, the planters turned to quinine, rubber, cocoa and finally to tea. The centre of coffee production shifted to Brazil where sometimes there was so much overproduction that the coffee berries were burned to keep up the prices.

The cloves, which we use in cookery and to sweeten the breath, are the dried flowerbuds of a tree known as *Syzygium aromaticum* belonging to the guava family. Shredded cloves are often mixed with tobacco to make scented cigarettes, and the oil is used to make vanillin, a substitute for pure vanilla. Formerly most of the cloves of the world came from the Molucca Islands and the Dutch held a monopoly for many years. Later, the plants were grown in Mauritius. One of the Sultans of Zanzibar introduced it into his kingdom and the adjacent Pemba. It is these two islands which now

supply 80 per cent of the cloves of the world and for many years they have lived largely on the export of this fragrant commodity. During recent years the clove industry of Zanzibar has faced grave peril because of the so-called 'sudden death' disease.

Then consider the cocoa industry of Ghana. The first fruit of *Theobroma cacao* was imported into the country and the owner could sell each pod for more than two dollars. Later the industry began to grow. During the five years from 1892 to 1896 the total production was only 12 tons, but in 1951 it had already climbed to 2,75,000 tons. During the last ten years the crop became afflicted by a disease called 'swollen shoot', which is caused by a virus and spread by an insect known as mealy bug. The eastern part was the worst affected and it was believed that the disease came from Togoland in 1930. It was feared that the cocoa industry of Ghana might have the same fate as the coffee industry of Ceylon. When orders were given to the farmers a few years ago to destroy the infected trees and burn them, they at first refused to do so. However, the government acted with vigour and firmness. The disease subsided and once again cocoa has had some big booms.

## The Indigo Satyagraha

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Dyes have long been used to (1) ward off evil spirits; (2) to frighten enemies; and (3) to make oneself more attractive. The world would be a drab affair without the multicoloured dresses of women and the neckties of men. Krishna and Baldev were called 'nilambara' and 'pitambara' because of the blue and yellow dresses they wore. In the *Mahabharata* we read about Prince Uttara removing the coloured dresses of the Kauravas

after they had been rendered senseless by Arjuna. The mummies in Egyptian tombs have been found clad in clothes coloured with indigo, madder and saffron. In the Bible there is a reference to the coloured dress of Joseph and how his brother envied him because of it.

Indigo was the king of all ancient dyes and was being grown in India from times immemorial. The dye was greatly in demand by the Greeks and Romans. After the Roman Empire broke up, indigo as a colouring matter was lost to Europe for centuries. But the Dutch reintroduced it in the middle of the 16th century and Bengal became the chief centre of the indigo industry. In 1631, on a single day, three Dutch ships took some 333,000 lb. of indigo from India to Holland. None of the Europeans had any knowledge of the source of the dye and even till 1705 they thought that it came from mines.

When the British occupied India, they found the crop so profitable that some of them established themselves as landlords in order to carry on the trade in indigo. They exacted from their tenants many kinds of fines and 'begar' (forced labour), and levied a tax on every marriage, hearth and oil mill. If the *sahib* needed an elephant or wished to pay a visit to the hills, the tenants had to bear the cost. The peasants had to grow indigo on a fixed proportion of the land they rented and this was never less than 3/20 of its area (the so-called *tin-kathiya* system). The planters also fixed their own price for the crop. When labour was hired, the wages were on starvation level—10 pice for a man, 6 pice for a woman and 3 pice for a child, working nearly 11 or 12 hours per day.

The tenants found conditions so difficult that sometimes they refused to fulfil them. However,

the British Government, which was more interested in the landlords than the tenants, passed special laws to terrorise the latter. Any cultivator, who was audacious enough to defy the planters, was harassed and subjected to all kinds of cruelties. His house would be looted, crops destroyed and stray cattle let loose on his lands. He would be dragged into false cases, made to pay fines or even beaten up. Sometimes, in sheer despair, the cultivators revolted and killed a planter or two. However, they were no match for the organised strength of the planters with the British Government behind them. Repression would be let loose and every revolt only worsened the peasants' condition. The late Dinabandhu Mitra wrote at that time a Bengali drama known as *Nildarpan* depicting the inhuman oppressions to which the cultivators were subjected. The man who translated the drama into English lost his job; the planters denounced it as grossly obscene and libellous, and the printer, Rev. J. Long, an English clergyman, was promptly prosecuted. He was sentenced to pay a fine of ₹1,000 and to serve one month's imprisonment. The fine was paid then and there by one Kali Prasad Sinha, a citizen of Calcutta.

Meanwhile Perkin (1856) synthesised indigo in England and the dye industry was developed to such an extent by German chemists that indigo plantations became unprofitable. The



**Fig. 7: The indigo trade had such an diverse effect on the life of the peasants of Bihar, that Mahatma Gandhi started his first Satyagraha movement at Champaran in 1917.**

planters now adopted the expedient of freeing their tenants from the obligation to grow indigo but charged them an enhanced rent or gave the land in return for the payment of a good sum in cash.

In 1914, World War I broke out in Europe and the import of foreign dyes stopped. The prospects for indigo brightened, and the planters again began forcing the tenants to grow indigo. Partly due to this and partly due to the damage caused to their economy by the war, their condition became more and desperate, and the situation was brought to the notice of Mahatma Gandhi (1869-1948) soon after he returned from Africa to India. The Lucknow session of the Indian National Congress adopted, in 1916, a resolution of sympathy with the peasants on the indigo plantations at Champaran at the foot of Bihar Himalayas. A villager, who attended the congress, went after Gandhiji from place to place and succeeded in bringing him to Champaran for an inquiry that made a turning point in Gandhiji's career (Fig. 7). Gandhiji agreed to conduct the inquiry with the late Dr Rajendra Prasad (Later President of the Indian Republic) and Mahadev Desai as his helpers and assistants. The Commissioner served him a formal notice under the notorious Section 144 of the Indian Penal Code, requiring him to leave Champaran. Gandhiji refused to comply and was put on trial. He read a statement in the court saying that his presence could not possibly disturb the public peace and that his sense of duty bade him remain where he was. This respectful but firm defiance took the magistrate by surprise. The Lieutenant Governor, Sir Edward Gait, ordered the case to be withdrawn, and made Gandhiji a member of an official inquiry committee. This committee stood

up for the peasants. The planters had to repay one-fourth of their unlawful exactions, the *tin-kathia* system was declared illegal, and land revenue was reduced. This was Gandhiji's first act of civil disobedience on Indian soil and, he immediately became a national hero. The Champaran struggle was a sort of small scale rehearsal in the technique of *Satyagraha*. Bigger things were to follow.

## **Cotton, Negro\* Slavery, England and India**

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Among the most interesting discoveries in the excavations at Mohenjodaro (Now in West Pakistan) (3.000 B.C. ?) were some pieces of silver wrapped in a fabric which was found to be cotton, the counts of yarns and the structure of the cloth indicating the attainment of a high degree of skill in the arts of spinning and weaving even in those distant times. This achievement may well be considered as more noteworthy than that of the Egyptians who were using the much longer stem fibres of flax.

Herodotus, the Greek historian and traveller, wrote in 445 B.C. that, 'there are trees growing in India, the fruit of which has a wool exceeding in beauty and goodness the wool of sheep'. Some writers concocted tales of a lamb sitting inside the fruit. The Greeks learnt of the cotton plant through the group of explorers who accompanied Alexander the Great and his immediate successors. From that time onwards the cultivation of cotton, its use for the manufacture of various fabrics, and their dyeing and finishing

progressed steadily until in the Middle Ages the fame of India's cotton materials spread far and wide and she had a roaring trade in them not only with the adjoining countries but also with far distant lands through Venice. Marco Polo mentioned the Coromandel Coast as producing 'the finest and most beautiful cottons in the world'. The softness, fineness and beauty of the Dacca muslins is legendary. It is said that when such muslin was laid on grass to bleach and the dew had fallen, it was virtually transparent. A whole garment could be drawn through a ring. There is also the oft repeated story of a Moghul princess who was putting on seven layers of muslin and still the contours of her body were so visible that she had to be admonished by her father.

Those glorious days were followed by a period of decline during which India's textile industry was discriminated against by the East India Company and later by the British Government. The revival came only in comparatively recent years.

India was, however, not the only country which grew cotton in the past. In the New World also cotton fabrics have been found in ancient Peruvian tombs. The Spanish discoverers of the Americas found cotton in the region from the West Indies to Mexico, Brazil and Peru, and in some of these countries the art of making cloth was highly developed.

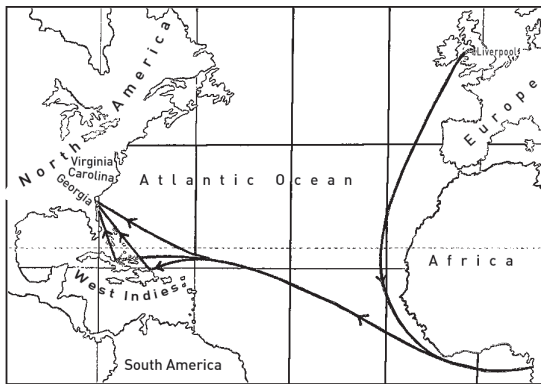
The introduction of cotton into the south-eastern area of the USA came much later. In 1621 some seeds were planted as an experiment and a coarse cloth was manufactured on a small scale towards the end of the century. In another hundred years

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\*The term Negro started to be considered derogatory and offensive around 1900s due to social changes. However, it has been retained in this article as it helps in understanding clearly the slavery prevalent long ago.



this textile furnished most of clothing of the poorer classes in the southern states. In 1747 some cotton was exported from America to England. In 1794 came Whitney's invention of the cotton gin which gave a tremendous impetus to the cotton industry. Henceforth, cotton became an important crop in the U.S.A.



**Fig. 8:** Route taken by the slave ships in the 16th and 17th centuries. The ships left Liverpool and touched the West Coast of Africa. After that they sailed west with their cargo of slaves, who were sold in the Caribbean Islands and south-eastern states of the U.S.A., to help in the cultivation of cotton and sugarcane.

It is to this extension of cotton cultivation in the U.S.A., that the negro problem of America must be traced. In the cotton growing areas the summer temperatures are rather high and there was an obvious need for cheap labour was necessary to bring more profits. The American Indians were a rather independent type of people who refused to co-operate with their white conquerors. Since a good proportion of the cotton for the Lancashire mills went from the southern states of the U.S.A., British ships found it a profitable business to capture negroes from the West African coast and sell them in America for work on the cotton fields (Fig. 8). To

economise space and transport of the largest number of negroes, the ships were specially made with galleries between decks. In these the unhappy negroes were made to lie down, all chained up lest they may try to escape by jumping into the ocean. The space allowed to each was five and a half feet long by sixteen inches wide. Later they also captured negro women and the State of Virginia made special efforts to breed negroes, for this was cheaper than carrying them across the ocean. Towards the end of the 18th and the beginning of the 19th century as many as 100,000 slaves were carried every year from the African Slave Coast. Having discharged their human cargoes, merchants loaded their ships with tobacco, sugar, rum and molasses and returned to England.

Differences arose about 1830 between the North and the South with regard to the slave trade and the legality of slavery. Apart from slavery their economic interests were also different. In 1860 Abraham Lincoln (1802-1865) was elected President of the U.S.A. He was opposed to slavery and his election was a signal for the South to break away from the North. He tried to bring about a compromise but failed. Eleven states of the South broke away from the North. Lincoln refused to recognise the right of any State to withdraw from the Union and a Civil War followed in 1861. All the early victories went to the South, but the North had much greater resources and in 1865 the South had to accept defeat. The negroes were made legally free and although incidents still occur sometimes, generally their condition is reasonably satisfactory and no worse than that of many untouchables in this country.

In the Old World the import of cotton cloth from England into India was one of the principal

reasons for the strained relations between the two countries. England took raw cotton from this country and sold the finished product to India. Lancashire grew fat, while the Indian peasant became poorer and poorer. Gandhiji, with the spinning wheel, emerged as a world figure, and the boycott of British cloth made the occupation of India unprofitable.

The Europeans came to India because of its rich plant resources particularly spices. When spices were no longer so important, it was still profitable to retain India as a market for British goods. Once India refused to buy them, it no longer remained the gold mine it was. Gandhiji's method was simple but sure, and India gained its independence in 1947.

## Recent Times

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In recent times everyone will remember that the chief reason for military aggression by Germany was not so much the *Lebensraum* or living space, which Hitler spoke of, but a consuming desire to occupy the wheat fields of the Ukraine and certain other areas to obtain more food for his crowded

population. A major reason for Japan's Blitzkrieg against Sumatra, Java and Malaya was her desire to close these, the world's most important rubber-producing areas, to the western powers and thus stop their supplies of a strategic material in war. Along with rubber, also went cinchona which was needed for the manufacture of quinine. This too was an important commodity for soldiers fighting in malarial areas.

## Conclusion

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In ancient times wars were fought for women. Sita, Helen, Padmini and Samyukta are well-known examples. Later they were fought for the spread of religious faiths. In the sixteenth and seventeenth centuries gold, spices and perfumes made history. Present day wars are not fought for women, or religion, or even gold, but for cereals, rubber, petrol (a plant-animal product), coal, iron ore, beryllium, thorium, etc. Who knows that in future also the desire of countries and nations to control plant and mineral resources may lead to major events in the history of the human race? Indeed, plant power is world power.

# THE UNBORN ONE

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I have seen hundreds of eggs, yet never have I been able to look through the shell and perceive the wonder within, never have I been able to appreciate the extraordinary genius of Nature hidden inside the wonderful egg. How does young chick, full of life, emerge from an egg, which to all appearance was a mere bit of sticky yolk? I could only find out by examining eggs of various ages.

The purpose of this project was to study the chick's development while still in the egg. I knew that there was something that happened in the egg when a hen sat on it, and perhaps that is how a chick is formed from the egg.

### Material and Methods

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Not much of equipment was needed. A few shallow vessels, a pair of fine scissors, forceps, a needle mounted on a handle, a blunt tongue-depressor, a medicine dropper, a few jam jars, 4 per cent solution of formaldehyde, and normal solution of 0.75 per cent saline were all that I needed. A few rings of different sizes cut out from filter papers, and a hand lens were my additional requirements.

I had an old box camera which had ceased to be of service and which I did not throw away. I had always thought that if nothing else, the springs or

the metal pieces could come in handy sometime or the other. When a microscope was needed for more detailed examinations of specimens, I took off all the lenses and reassembled them in a cardboard tube using candle wax to fix them properly. With my textbook knowledge of optical instruments, I managed to improvise a working microscope which could enlarge objects nearly 50 times.

For my project, at least a dozen eggs of known ages were needed. Artificial hatching was necessary. Knowing the requisites of an artificial hatching device, I proceeded to model an incubator.

An old wooden box was taken. To this was fixed a night bulb and a lid. Three holes of half-inch diameter were made on the top; one on the right hand corner, one on the left hand corner, and a third in the middle. I lined the inside of the box with cotton-wool (for insulation) and plugged the two corner holes with cotton. A centigrade thermometer fitted into the third hole revealed the inside temperature. This was not enough. The humidity had to be maintained at 50 to 70 per cent. A coffee-can filled with water and a small piece of mudpot kept partly dipping in the water helped to maintain the proper level of humidity. I refilled the water in the coffee-can whenever it dried up.

All that I had to do to set the incubator working was to close the door of the incubator and switch on the bulb and after every two hours or so, read the temperature from the thermometer. By judiciously opening the two corner holes on the top, I maintained the required temperature between 30°–40°C.

## Experiment and Observation

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I next bought a dozen hen's eggs from a dairy, marked on them with a pencil, the date of purchase, and placed them in the incubator. All set, I launched on my project. Here are my observations in brief.

On June 18, I opened a fresh egg and studied the internal structure. An oval ball of yellow yolk in the centre was separated from the surrounding colourless, jelly-like albumen. On either side of the yolk, reaching up to the end the egg was a twisted chord, the *chalaza* (Fig. 1).

The egg was protected by a thick shell. Between the shell and the contents of the egg were two thin membranes. At the broader end of the egg, the two membranes separated out to enclose a little air between them. On the dorsal side of the yolk was a white speck, the *blastodisc*, placed directly in the centre.

After waiting for a day, I opened another egg. I held the egg in my palm so that it rested on its larger side. I then poked carefully a needle on the side of the egg, about half an inch from the top. Then I inserted a pair of scissors into the hole and cut round the egg. Having done this I lifted, with forceps, the top, as if it were a lid.

To my disappointment I found that there was no development in the egg. I had misgivings about

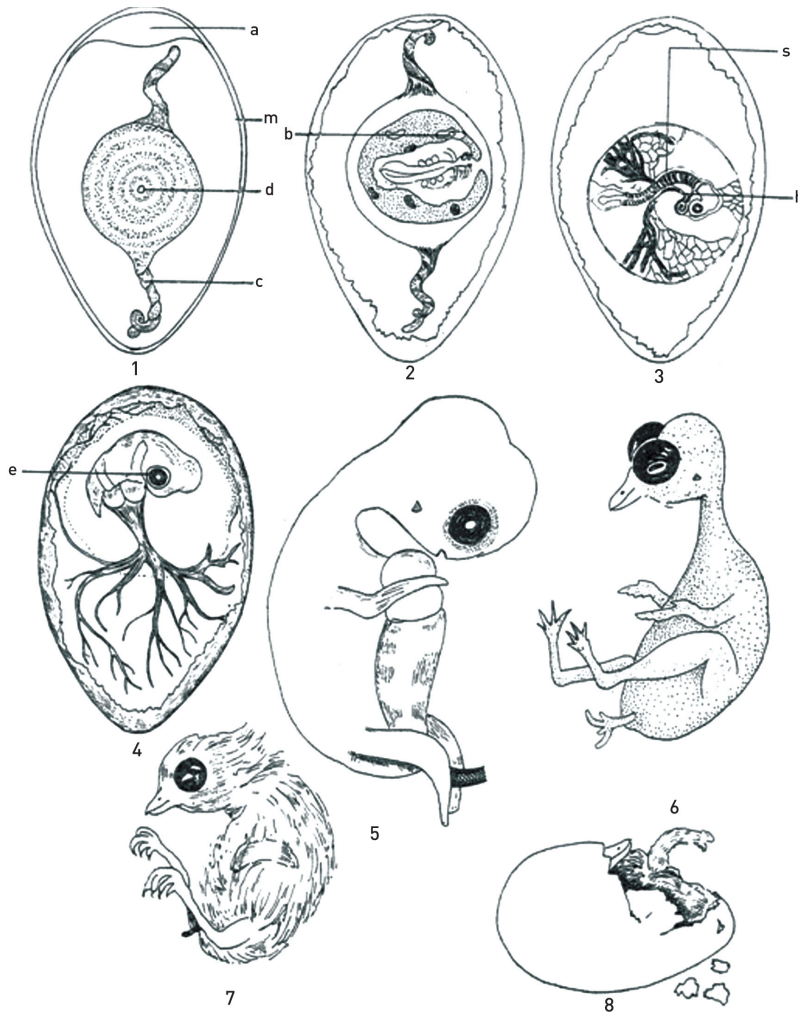
the effectiveness of my incubator. Then someone told me that when the cocks are not sufficient in number to mate all the hens in the poultry, there are chances of some eggs being unfertilised. This was news to me, for I had presumed that all eggs could produce chicks. Now I understand that the male unit of reproduction (*sperm*) that is required to fertilise the egg does not enter all the eggs and hence the existence of unfertilised ones. One thing I noticed was that the *blastodisc* was always on the dorsal side, no matter in which position I held the egg. I held one of the eggs in a certain position, and then turned it upside down and cut it open quickly, and found that the yolk was slowly turning sideways so that once again the *blastodisc* came up to the dorsal side of the yolk. So there must be some factor that makes the *blastodisc* always incline towards the dorsal side.

The next few days found me going from place to place in search of fertile eggs, until by chance I came across a poultry farm where fertile eggs were being sold. The man assured me that at least 80 per cent of the eggs would be fertile. I bought a dozen of these eggs and placed them in the incubator with fresh hopes.

My persistence did not go unrewarded, for after a day of incubation I opened an egg and found, to my joy something more than what I had seen in a fresh egg. In place of the *blastodisc*, a more or less discoid area clearly differentiated from the remaining yolk surface was seen. At the periphery of this area were a number of spots which perhaps had something to do with blood. Within this area was a membrane less opaque than the outer area. This membrane bore a thin stick-like structure with a knob in front. On closer

examination I found that that was the embryo which later would develop into the chick. This had a minute hole at the tip of the head. Right down the middle of the embryo ran a thin groove.

Farther down, on either side of the groove were six paired blocks which made the groove look like the spinal cord, while the blocks themselves looked like vertebrae in section (Fig. 2).



**Fig. 1:** The Structure of an egg: embryo a mere speck. **Fig. 2:** The 1-day embryo: a tiny rod. **Fig. 3:** The 2-day embryo: heart appears. **Fig. 4:** The 5-day embryo: Limbs are seen. a = air sac; b = blood island; c = chalaza; d = blastodisc; e = eye; h = heart; m = shell membranes; s = somite **Fig. 5:** The 8-day embryo: the ear is visible. **Fig. 6:** The 10-day embryo: the heart is pushed into the body. **Fig. 7:** The 12-day embryo: developed but pre-matured. **Fig. 8:** Hatching: birth at last.

The next day I examined an embryo that had been incubated for two days. The embryo that had during the first day of development been lying on its back, now lay on its side. The chalaza was absent. The embryo had the shape of a question mark. I realised the existence of a small bag which became red and pale-pink alternately. This was engulfed in the anterior area. I recognised this as the heart. I traced a number of blood vessels through which the blood, fresh and wine red in colour was flowing in spurts. This was not so readily visible to the naked eye, but my improvised microscope enabled me to see the spurting movement of blood.

Finally I understood; the embryo 'feeds' on the yolk particles. Since its mouth is undeveloped, the embryo 'eats' by another well contrived device. It pumps blood to the yolk membranes. The blood, while passing through the yolk, takes up a number of yolk particles and carries them back to the heart. This yolk-laden blood is then circulated within the embryo. The embryo thus has two types of circulation at this stage—the embryonic circulation and the extra-embryonic circulation.

This stage of the embryo had 23 of those paired blocks, or *somites*. A few drops of saline produced movement of the embryo. To preserve this embryo, I took a filter paper ring, a bit smaller than the *embryonic disc* (area where the embryo and blood vessels lie). Placing the ring on the embryonic disc, I cut around the filter paper. I then lifted the embryo along with the paper ring, using forceps, and placed the embryo in a petri-dish containing normal saline, solution.

After the adhering yolk particles had been washed off, I carefully transferred the embryo to a petri-dish containing a 4 per cent solution of formaldehyde.

I was surprised at the appearance of limbs in an embryo which had developed for five days. The embryo was enclosed in a sac containing some fluid (Fig. 4). The unborn chick had a pair of forelimbs, slightly bigger than the hind limbs which, unlike the forelimbs, ended in conical structures.

The heart was divided into two chambers. Each pumped blood alternately. The heart ended in a tapering structure which branched off as blood vessels.

A few drops of saline made the embryo shrug. The poor creature seemed to cling desperately to its heart, with its weak limbs.

After this, I turned the eggs upside down daily. (I do not know the purpose, but someone told me to do so).

I have never had nor will have the opportunity to experience what a mother feels when she sees her child play and grow everyday. But this project provided a near substitute, for everyday found me watching intently the growth of the 'chick' with increasing joy.

After eight days of development an embryo is a real thrill of joy to see. The big outsized brain, the disproportionately huge eyes protruding out of the head, the small opening between the two eyes that later becomes the mouth, the two small triangular openings for hearing, the huge heart which completely covers the front part of the body, the four big folded limbs; all this on a small curved body—this is the splendid sight that an 8-day embryo affords (Fig. 5).

A beak on an embryo that does not in any way resemble either a bird or a chick is very odd. All embryos younger than the 10-day embryo had

their eyeballs attached superficially, but in the 10-day embryo, the eyeballs were buried and covered by the surrounding skin. All along, the heart had been outside the body but in the 10-day embryo, all but the big blood vessels arising as a continuation of the tapering portion had been pushed into the body. The limbs were bigger and forked. The skin was covered with small dots which looked more or less like buds (Fig. 6). I stored all these embryos in bottles containing 4 per cent solution of formaldehyde and labelled them according to age.

A twelve-day embryo is in all respects similar to a fully grown chick; only, it is smaller. The whole body is covered with silky hairs, the hind limbs end in four well-developed toes and the forelimbs look like wings (Fig. 8). When I opened a 12-day old egg, I found the eyelids of the embryo slightly open.

Taking an incubated egg, 20 days old, I carefully peeled off the shell without injuring the interior. To my surprise, I found something poking out of the membranes covering the embryo. I felt it with my fingers and the thing moved: I could hear a squeaking sound. So that was the beak: it had pierced through the membranes for drawing air from the air sac. I tore away the membranes and found a chick, developed in all respects. It really was a wonder to find such a huge chick enclosed in a shell so small as that.

Two more eggs remained, and they were nearing their hatching hour? My calculations told me that the struggle for freedom would start sometime at midnight. Making a safe guess, I fixed my alarm clock to ring at 2 O'clock. The ringing of the bell

at 2 O'clock next morning roused the whole family. I went to the incubator and to my disappointment, found no signs of birth. Then suddenly, I heard a low knocking sound quite distinct and regular. I picked up that egg from which the sound came. (Eventually I was to discover that the other one was unfertilised).

So at last my chick was striving to come out of the shell. I carefully lifted the egg and placed it on a cotton spread.

The struggle started. The chick pecked at the hard shell. After a few minutes' rest it attempted again, and again, until, finally it succeeded in making a crack on the shell, then a small hole. It pushed out its beak through the hole and started sawing with the hard sides of its beak. The hole grew larger and the energetic bird worked on unceasingly. It had lived nothing—but a small mass of yolk for past twenty—one days; yet the energy and unflinching determination that it possessed was remarkable. 'What gives such motive force?' I wondered.

Finally, the forelimb of the chick emerged. The beak moved behind the shell once again so that it became out of sight. The beak pecked from one side and the forelimb fluttered from the other until the shell gave way (Fig. 8). This went on until nearly half the shell was chipped off.

It was 07.09 hours. The chick was relieved of all bondage. *My chick was born.*

Like a hen, I had, for the past twenty-one days, meticulously incubated the eggs, and here was my reward—my sweet young one.

# FAUNA OF OUR OCEANS – LITTORAL LIFE

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The word 'ocean' is derived from the name 'oceanus' which the Greeks had given to a river that flowed, according to them, around the earth considered by them to be flat. However, as our knowledge about the earth and the oceans surrounding it increased, the wheel maps of the olden days were replaced by the most modern ones which now tell us that there are three great oceans in this world, viz., the Atlantic, the Pacific and the Indian. The last one is named as such because it washes our shores which extend over nearly 4700 kilometres.

Regarding the origin of these oceans, it may be stated that in the beginning, even the earth was just a part of the sun. It was, therefore, as hot as the sun itself when it separated from it. Gradually, however, it cooled down with the result that its outer surface became rocky, but the inner portion still remained at a very high temperature on account of the hot gases which originally constituted it. These occasionally caused the eruptions of some of the rocks at their tips with the result that huge craters were formed and the hot lava flowed down the rocks. As a consequence of the high temperatures prevailing on the surface of the earth, it remained surrounded by clouds formed due to the condensation of the atmospheric vapour. Gradually, however, these clouds rained and the water, this collected in the

huge craters and the valleys in between the rocks, formed the oceans.

Those who have been to any coast know that the sea water rises and falls at regular intervals. Such arise and fall in the level of sea water constitute what we call the high and the low tides respectively. These are caused by the force of attraction which both the moon and the sun exert on our waters. The impact of the rising tides on the rocks is so great that they are broken completely with the result that we have sometime a shore which, instead of being rocky, is just in the form of a sandy beach. Besides these two types of shores, i.e., rocky and sandy, there is still another type which is muddy. Such a shore is found either at the mouths of the rivers or in some sheltered creeks.

The strip of land which lies between the high- and low-water marks and which becomes uncovered twice daily when the tide is at its lowest ebb is known as the littoral zone of the sea shore. The conditions in the zone are so variable that the animals living comfortably in the cool waters of the high tide may be found stranded at the time of the low tide in a rock pool in which the temperature of water on account of the hot sun may even rise to such an extent as to cause the death of all the organisms living therein. Even the



nature of the sea water itself is bound to change especially near the mouths of the rivers on account of its mixing up with the fresh water. On the other hand, the sea water in certain enclosed areas may become even more salty on account of its greater evaporation during summer.

In order, therefore, to successfully adapt themselves to such varying conditions, the animals living in the littoral zone have to be very tough and hardy. In spite of all these handicaps the fauna of the sea shore is so varied and dense that we have not got its parallel anywhere else. There is a continuous struggle going on between the inhabitants of the sea shore not only for their own existence but also for their food and reproduction. In this struggle only those animals which are strong and well protected survive and the others die. Their death can, however, be avoided only if they succeed in hiding themselves from their enemies.

We shall now describe some of those animals which live on our rocky shores. First of all we come across the sessile barnacles like *Balanus* firmly attached to the rocks in the form of small pyramids. They constitute a definite *Balanus* zone near the high-water mark. The common limpet, *Patella* may also be seen browsing on the sea weeds found in this area. Then there are the *Chitons* with their shells divided into eight pieces. Near the low-water mark the rocks are found covered over with a carpet of sponges of the various colours, colonial sea squirts like *Botryllus* and sea mats like *Membranipora*. We may also get here the various types of bivalves like the oysters, *Mytilus* and *Pecten* etc. whereas the oyster is permanently attached to the rocks by means of its shell, *Mytilus* and *Pecten* make use of their tough

fibres constituting the 'byssus' to secure themselves.

Some other animals become exposed as soon as we start turning over the loose stones lying on the sea shore.

Just near the high-water mark, we get a number of small crustaceans like *Gammarus* and insects like beetles. As we go down the sea shore, we get *Lineus* and some other nemertines. These worms are sometimes so long that it becomes impossible to take out a complete specimen without breaking them. We may also come across small techni-coloured flatworms, moving slowly on the surface of the stones. Then there are the various types of bristle worms and as we reach the low-water mark, we also get specimens of *Nereis* which are generally used as a bait. There is another common worm *Polynoe* which is not only broad but also flattened. It is also provided with two rows of very large scales on its dorsal side, enclosing a space between them and the body wall which serves as a respiratory chamber. From amongst the crustaceans, the crabs are so common that you will get one variety or the other whenever you turn over any stone. The most characteristic of these is the hermit-crab which lives inside the empty shell of a gastropod and on that may occasionally be found attached either a small sea anemone or a sponge. Such an association of animals belonging to widely different groups is known as commensalism. In this type of association the sea anemone or the sponge provides protection to the hermit-crab and in return gets food by going from one place to the other riding on the swift moving hermit-crab. Starfishes and sea-urchins are also quite common near the low-water mark. Where the

former have five arms radiating from the central disc, the latter are globular and covered over with long and thick spines. Another unique feature of both of these echinoderms is the possession of a water vascular system which is so useful in locomotion. Some of the small fishes are also found hiding underneath the stones on the sea shore. Once, while looking for animals on the rocky shore near Dwaraka, we could collect even an eel in a similar situation. But it was really in a very ferocious mood when we located it underneath a stone and we had to do quite a good bit of manoeuvring before we could get at it.

Then in the holes and crevices of rocks are also available the various kinds of worms, crustaceans and echinoderms like the Holothurians. Some of the rock burrowing molluscs like *Lithophaga* stryocotopus which may be lurking here and there in search of fish or crustaceans on which it may dart without giving them any notice whatever. Another interesting feature about octopus is it can evade its enemies by making the water turbid with the ink which it gives out from its ink-sac while fleeing swiftly.

The most fascinating spot on the sea shore for a zoologist is, however, a typical rock pool. The various types of sponges, hydroids, sea-mats and sea-squirts cover its sides. But among them the sea-anemones become all the more prominent because they just look like flowers with their rich and beautiful colours. Then there are the sea-slugs with their backs covered over with soft and grey projections, the sea-lemon, *Doris* and the prawns of various kinds.

In contrast to a rocky shore, the sandy shore has an entirely different type of fauna. On such a shore all the encrusting animals are quite conspicuous

by their absence because they do not find here any hard structures to attach themselves. As most of the animals on a sandy shore have to spend a good deal of their time under sand, they are very efficient in burrowing. For example *Cardium* can not only move about but also burrow by means of its wedge shaped foot which it can protrude through the opening in between the two halves of its shell. In some of the burrowing molluscs, the shell is ridged so that they may have a better grip on sand. The razor-fish, *Solen* may also be dug out occasionally at the time of low tide. The two halves of the shell in this mollusc form a cylinder which is open at both ends. Whereas the lower opening is for the protrusion of the foot, the siphons come out of the upper one. Besides the molluscs, there are a number of worms found buried in the sand with only their tentacles exposed. Of these, the Terebellids can be easily made out on account of their sandy tubes.

*Amphitrite* is another important member of the fauna available on the sandy shore and so is *Arenicola* which can be easily recognised by its peculiar castings just like those of the earthworm on land. Quite near these castings one can also notice a small depression at the base of which is situated the head of the animal, its burrow being U-shaped. Another animal found on a sandy shore and which may be easily mistaken for a worm is *Synapta*. This is, however, an echinoderm and is related to the sea-cucumbers. Similarly, the cake-urchin, *Clypeaster* may also be occasionally dug out of the sand.

We also get here a number of crustaceans like the shrimps which can often be missed on account of their sandy colour. Besides them we have the various types of sea anemones which lie buried in sand with only their mouths and tentacles

exposed. Some of the fishes can also be encountered in the shallow waters of the sandy shores. Occasionally they may be stranded in small pools on the sea beach. Similarly, some of the jelly-fishes and Siphonophores like *Physalia* or the Portuguese Man-of-War and some sea-snakes are also left stranded on our sandy shores.

On a muddy shore also the burrowing forms are as abundant as they are on a sandy shore. They may be bivalved molluscs or worms of the various types especially those found in the tubes. Of these, *Sabella* is provided with a rubber-like tube which, on the other hand, is quite thick and gelatinous in *Myxicola*. Then there are several varieties of sea anemones and crabs. Some of the air breathing fishes like *Periophthalmus* and *Boleophthalmus* may also be encountered on our muddy shores. It is, however, very risky to collect these animals because one may often sink knee deep while hunting after them in mud. Another group of animals which is equally well represented on a muddy as well as a sandy shore is that of Gephyreans. They include the Echiurids and Sipunculids. The Echiurids have a ribbon-like proboscis which is richly ciliated and glandular. The cilia help this animal in bringing towards its mouth minute microscopic organisms which are then glued together by the secretions of the glands. The forms which are commonly met with in our littoral zone belong to the genera *lkedosoma*, *Ochetostoma* and *Anelassorhynchus*.

The Sipunculids are characterised by the possession of a peculiar organ called the 'introvert' which can be withdrawn when not in use. Another feature of this animal is the shifting of the anus towards the anterior end with the result that the antero-posterior axis is shortened.

This brief survey of the animals in our littoral zone will not be complete if I do not make any mention of the coral reefs and islands. They are formed mainly by the stony or Madreporarian corals which are also coelenterates just like the sea anemones. The only difference is that they secrete around and underneath themselves a thick skeleton of calcium carbonate. The corals may be solitary but most of them are colonial, each colony comprising a large number of individuals, their skeletons being fused together to form a very big stony structure. The corals which are generally displayed in our museums are only these skeletal remains which during life are covered over by the living tissues of the animal with the feeding polyps opening and closing rhythmically. There are also a number of corals which are just hydroids differing from them only in having a thick and calcareous skeleton. *Millepora* which is one such coral possesses two types of polyps—one devoid of a mouth but with batteries of stinging cells used for capturing the prey and the other with mouth for swallowing and digesting it. *Tubipora* or the organ pipe coral is another important constituent of the coral reefs. It is, however, a false or Alcyonarian coral in which the skeleton is in the form of a large number of small tubes running parallel to one another. They are deep red in colour and are united by horizontal platforms. During life the green tentacles of the polyps can be seen projecting out from the free ends of these tubes. Only the upper portion of this coral is provided with living tissues, the lower being abandoned with the gradual growth of the colony. The latter, therefore, becomes a wonderful abode for a large variety of animals. The Bonellids, for example, with a bifid proboscis are usually found in some of these coral rocks. The males of

Bonellids are minute worm-like creatures showing no resemblance whatever to the female which, however, is quite big. The former lives like a parasite inside the nephridia or the uterus of the latter drawing its full nourishment from the host. The sex in this case is supposed to be determined by the environment, because the embryo grows into a female if it is allowed to develop independently. But if during development it comes in contact with a female, it grows into a male.

It will, thus, be seen that in the littoral zone of the sea shore one can find a great variety of animals, ranging from the minute unicellular protozoa right up to the most highly evolved mammals like the dolphins and porpoises which are sometimes left stranded there. Similarly, the penguins, seals and walruses visit the coasts during their breeding season. Even the sea turtles are known to lay their eggs in sand on the sea shore.

# NEW LIGHT ON THE SPREAD OF LEPROSY

## R.J.W. Rees

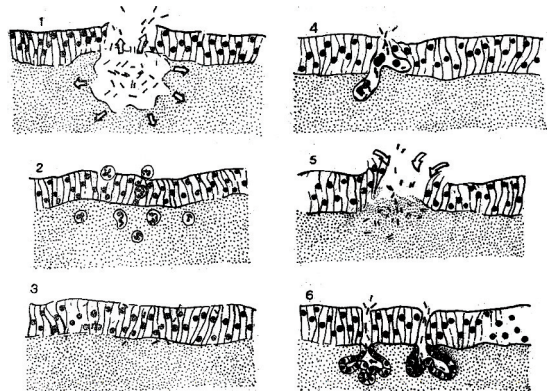
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Research in the last few years indicates that, contrary to popular belief, leprosy is most readily transmitted through the nose, where it forms a seat of infection long before other symptoms have become noticeable. The correct explanation was postulated by 19th century doctors in clearly documented observations, which apparently no one followed up.

Leprosy is one of the major diseases in the world today, affecting well over 10 million patients, mainly in the developing countries. It is an infectious disease caused by a bacterium, *Mycobacterium leprae*, related to the tubercle bacillus. Leprosy, like tuberculosis and the other major infectious diseases of man, was recognised as having a bacteriological etiology in the latter part of the last century. But advances in our basic knowledge of infectious diseases which have led to successful methods for their control and treatment have, unfortunately, not helped with leprosy.

The reason it has lagged behind is that, unlike the other causative bacteria, *M. leprae* failed to grow in the test tube (*in vitro*). But while all attempts to cultivate *M. leprae in vitro* have failed, in 1960 Dr. Shepard showed that *M. leprae* recovered from tissues of patients with leprosy multiplied when inoculated into the foot-pads of mice. This mouse foot-pad technique provided for the first time a laboratory method for studying the bacteriology of *M. leprae* and in the last 14 years it has been extensively exploited as a substitute for *in vitro* cultivation of the other major infectious agents of

man. In this relatively short period, the mouse foot-pad technique has enabled our knowledge of leprosy to catch up with that of the other infectious diseases.



In many of these studies the mouse foot-pad infection has been used simply as a substitute for *in vitro* cultivation, but it does have the added advantage providing a laboratory model for elucidating the disease process. It is on the basis of these combined features of the infection in mice that the Medical Research Council, at the National Institute for Medical Research, has attempted to elucidate the mode of transmission in leprosy.

## Previous Clinical Concepts

There are broadly speaking two forms of leprosy, the tuberculoid and the lepromatous, and while in both there are skin manifestations and nerve damage resulting from invasion of the tissues by *M. leprae*, there are very many more bacteria in lepromatous than in tuberculoid leprosy. The most heavily infected sites in patients with lepromatous leprosy are the skin, nose and upper respiratory tract so it is from these sites that excretion of bacilli is to be expected. Indeed, in the late 19th century Sticker and Schaffer demonstrated large numbers of bacilli in nasal discharges from leprosy patients and postulated that leprosy was transmitted by bacilli from the nose.

In spite of these early and clearly documented observations, they seem to have been forgotten, since 'prolonged and intimate skin-to-skin contact' has for many years now been favoured as the most likely route of transmission. This probably derived largely from the obvious cutaneous clinical signs of the disease, despite the paucity of bacilli found on the skin surface.

However, from the clinical side interest in the nose and nasal secretions as sources of infection was reawakened in 1970 by Dr. J.C. Pedley working then in Nepal. He convincingly demonstrated many bacilli in stained smears of nasal discharges from patients with lepromatous leprosy, but insignificant numbers of bacilli on the skin surface.

## Leprosy in the Mouse

At the time of Pedley's observations in man, our systematic studies at the National Institute for

Medical Research on the evolution of infections with *M. leprae* in the mouse had pinpointed the nose as being a site of particular interest. Thus, the nose appeared to be a favoured site for the localisation and multiplication of *M. leprae* when the infection spread from a locally inoculated foot-pad. The nose was more frequently and more heavily infected than any other tissue site and bacilli were discharged in secretions from the nose, but not discharged from skin sites.

On the basis of these observations in the mouse and Pedley's observations in man a multi-disciplinary project was undertaken to reappraise the clinical, bacteriological and pathological aspects of the nose in leprosy patients, applying techniques which would be likely to determine the importance of nasal infection in the transmission of leprosy.

**Average annual age and sex specific attack rates for tuberculosis leprosy in family contacts, South India**

Age	Male		Female	
	Tuberculosis	Leprosy	Tuberculosis	Leprosy
0-4	4.0	4.4	3.8	5.6
5-14	1.8	7.3	1.6	2.1

\*Survival of *M. leprae* in dried nasal secretions after discharge

Number of nasal secretions tested	Time after discharge (days)	Survival of <i>M. leprae</i> *
3	0	100
3	1.0	100
2	1.75	10
2	3.0	0
1	7.0	1**
1	10.0	0

Allowed to dry in the dark at a mean temperature of 20.6°C and mean humidity of 43.7 per cent

\*Assessed as infectivity in the foot-pads of mice

\*\* Growth of *M. leprae* obtained in only 2 of 12 foot-pads

Thus the bacteriological studies were of prime importance and for these the mouse foot-pad infection was fully exploited.

### **Clinical and Experimental Reappraisal**

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The essential clinical link for this study was based on Dr. T.F. Davey at Victoria Hospital, Dichpalli, India, who in 1972 had just completed an extensive study on the clinical and bacteriological aspects of nasal discharges of 936 leprosy patients, which he had undertaken because of Pedley's observations. Davey's data fully confirmed Pedley's findings. In particular, his detailed and meticulous records showed that bacilli could be present in large numbers in nasal secretions when, because of the gross appearance of the patients, skin lesions were not obvious and could easily be missed by routine examination. And, on questioning, patients were found to be aware of unpleasant nasal symptoms, described generally 'sticky noses', and of the frequent presence of blood in their nasal discharges.

In collaboration with Davey, single or 24-hour collections of nasal discharges were taken from a representative sample of patients with active and early forms of lepromatous leprosy. Detailed quantitative studies and biological identification of bacilli from these samples were undertaken in London using the mouse foot-pad technique. These showed that such patients were discharging on average  $10^7$  viable bacilli daily and that the organisms had the characteristics of *M. leprae*.

Advantage was also taken of the opportunity to study the survival of *M. leprae* in these natural nasal secretions when allowed to dry in the exterior environment, for example, on stone surfaces or in handkerchiefs. Survival was assessed by inoculation of these dried specimens into mice. The studies showed that *M. leprae* was fully infectious for mice one day after drying, some 10 per cent were still infectious at approximately two days, while in one such specimen approximately one per cent of bacilli was still infectious at seven days.

These studies established for the first time that *M. leprae* is relatively robust and can survive drying, in the dark, for several days in natural nasal secretions.

### **Near the surface**

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In addition to the bacteriological studies, detailed clinical and histological observations of the nose were undertaken in collaboration with Davey and Mr. R.P.E. Barton, an ear, nose and throat specialist, on 36 patients with early lepromatous leprosy. From each of these patients 3-5 small pieces of tissue were taken from nose by Mr. Barton. Representative samples of these tissues were submitted for bacteriological examination and for histological examination by Professor A.G.M. Weddell and Dr. A.C. McDougall at the Department of Human Anatomy, Oxford.

Quantitative bacteriological studies on these tissues as compared with pieces of skin from the same patient showed that the nasal tissues were more heavily infected and contained a higher proportion of viable *M. leprae* than the skin. The histological studies confirmed this, but even more important were, the finding that the leprosy

infection in the nose was only just beneath the surface mucosa, which was often invaded or eroded. Bacilli were frequently present in the cells of mucus glands and ducts. Small blood vessels reached up to the denuded surface of the nasal mucosa and these vessels were dilated and frequently undergoing degeneration.

These histological observations clearly demonstrated the ease with which *M. leprae* could reach the surface of the nasal mucosa and be discharged into the exterior.

Such a multitude of escape mechanism of bacilli from the nose fully explained the large numbers of *M. leprae* present in nasal secretions. The histological situations in the nose, therefore, were in complete contrast with that in the skin, where the leprosy infection was deeply situated and not in juxtaposition with the skin surface. In fact the skin infection was clearly separated from the surface by a bacillary free zone-referred to as the 'clear zone'.

A particular feature of the histology of the nasal tissues was the invasion of bacilli into the lining cells of the blood vessels and the presence of very large numbers of bacilli free within the lumina of the vessels. Because it was impossible to obtain samples of blood from these vessels, an attempt was made to estimate the number of *M. leprae* present by measuring the area of these tissue-sections and their thickness. On the basis of these assessments it was shown that approximately  $10^9$  bacilli/ml blood were present.

## Implications

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These specially designed multi-disciplinary studies not only add considerably to our

knowledge of nasal infections in patients with leprosy but provide very strong evidence in support of the nose as the primary site by which leprosy bacilli are discharged to the exterior, and therefore the importance of the nose in the transmission of the disease.

Thus, for the first time bacilli discharged from the nose have been established *M. leprae* by their behaviour when inoculated into mice. Moreover, the number of *M. leprae* discharged daily from the nose of lepromatous patients in comparable to the number of tubercle bacilli discharged in the sputum of patients with open and active tuberculosis. Of still greater significance is the evidence that *M. leprae* are relatively robust and can remain viable in dried nasal secretions for several days. Detailed histological studies of nasal tissues clearly show how readily bacilli can reach the surface and be discharged from the nose as compared with infections in the skin.

Together, these findings begin to build up a composite picture for the possible mode of spread of leprosy that has not hitherto been available, at least on the basis of scientific evidence. For not only do they suggest a source of infection, they also offer a possible explanation for the apparent failure of the chemotherapy used for overt disease to help with primary prevention of leprosy in endemic areas. The early lepromatous patient, shedding millions of *M. leprae* from nasal lesions, may infect many people in his family or in his environment before he is diagnosed; and his subsequent treatment may be largely irrelevant in terms of his ability to spread the disease further.

This is a pessimistic picture, but it is important to recall that patients at an early stage have symptoms of nasal blockage and bloodstained



nasal discharges. Therefore it may be possible to identify cases earlier by stressing the importance of these symptoms.

Spread involves not only a source of infection but also a portal of entry. Here analogies with tuberculosis may be helpful. Clearly, *M. leprae* could be spread by sneezing, coughing, spitting and unhygienic nose-cleaning methods—so in many respects by way of droplets, as in tuberculosis. In this context, the similarities in bacterial loads from nasal secretions and sputum of patients with lepromatous leprosy and open tuberculosis are of considerable interest.

Clearly, the portal of entry could still be the skin; but, equally, *M. leprae*-laden particles could also be inhaled or swallowed. It is therefore of interest that the attack rates for the two diseases in household contacts are of the same general order, especially in the young. These comparisons prove nothing, but they do suggest—and really for the first time—scientific ways of studying leprosy transmission.

## Back to the Bloodstream

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An unexpected but very significant finding from the histology of nasal tissues from leprosy patients was the very high concentration of bacilli free within the lumina of nasal blood vessels. As I

have said, calculations from these tissues indicated an order of  $10^2$  bacilli/ml of blood.

This tremendous difference between the concentrations of bacilli within vessels of the nose compared with the general circulation is again of particular importance. It could be that the special vasculature of the nose is acting as a 'backwater' in which bacilli from the general circulation gravitate. However, bearing in mind the particularly high concentration of *M. leprae* in nasal tissues, plus the evidence from the mouse that the nasal tissues are a favourable site for the multiplication of leprosy bacilli, it seems more likely that the nose is also a site from which bacilli are readily shed into the bloodstream.

If this is true then nasal infections in leprosy are of the greatest importance since they represent not only a site from which bacilli reach the exterior and lead to the transmission of leprosy but also a particularly favourable site from which bacilli are fed back into the rest of the body.

So the application of sophisticated biomedical techniques now implicates the nose in elucidating many of the mysteries surrounding the pathogenesis and transmission of leprosy. But those who have diligently applied these techniques must admit that this is what our forefathers hypothesized in the late nineteenth century.

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# CONCEPTS OF 'ULTRA-DIMENSIONS' AND 'THERMODYNAMICS' FOR YOUNG CELL BIOLOGISTS

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Cells are visible mostly through the help of optical microscope and their organelles usually are seen through the electron microscope. Various organelles of cells, though small in size, perform vital functions. All the food we consume is synthesised by tiny chloroplasts of the green plants and used up by still tinier mitochondria in the cell. The magnanimity of the tasks performed is inversely proportional to the size of the 'performer.' A young, high school cell biologist may know about the structures and functions of the various cell organelles, but he is hardly able to develop an appreciation of the diversity of the size-range on ultra-dimensional scale and the intricacies of the reactions on such minute sites.

Further, the cellular processes, at least many of them, have been resolved in terms of chemical reactions which obey the same physico-chemical principles as applicable to *in vitro* systems. Therefore, a clear understanding of these principles becomes prerequisite of the teaching of the essentials of cell biology.

In the present article an attempt has been made to show the way to teachers and students as to how to absorb and assimilate these 'so called' hard concepts.

## THE ULTRA-DIMENSIONS

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### The Scales

We talk of larger organisms in terms of metres (m) the small ones or their body parts in terms of centimetres (cm) and those still smaller but visible through unaided eyes or a dissecting scope in terms of millimetres (mm). These units are all comparatively larger and within the range of the resolution of human eyes. But with the exception of certain giant cells of algae, etc., other cells as well as their parts fall under much lower range of the measuring units thus requiring some mental training for actual visualisations. These ultra or micro-dimensions recur very frequently in cell biological literature. It is not just enough to know that a micron ( $\mu$ ) is  $10^{-3}$  mm and an angstrom ( $\text{\AA}$ ) unit is  $10^{-7}$  mm. The mind must be able to carry out a mental abstraction from the sub-visible dimensions to visible units and realise the need and utility of finer resolutions and magnifications. The earlier is this achieved by the learner the more effective it would be in assimilating the concepts and principles of cell biology. There may be several ways in which this could be accomplished. Indeed, each learner would develop his own

mental process to achieve this visualisation, but a few approaches are suggested here which would particularly aid an average learner. One way could be to discuss and work out such problems as how long a metre scale would look if it were reduced one thousand times, and then again, to one thousand times. The process may be repeated till one reaches the value of an Å or a nanometre (nm). Similarly, an exercise may be carried out as to how much two dots as close 1 Å must be magnified so that they are seen clearly apart through unaided eyes. At this stage the resolving power of the human eyes may be given as about 1/5 mm. It is possible that some learners already possess this sense of reduction-magnification, if already trained in mathematics. If so, one could do the following exercise straightaway on the basis of his earlier knowledge of the names of cell components and the ability to draw histograms. The following set of data or a similar set may be tried out as a classroom activity:

Cell diameter	100 μ
Nuclear diameter	15 μ
Chloroplast length	5 μ
Mitochondrial diameter	2 μ
Lysosome	1 μ
Cell wall width	2 μ
Plasmalemma width	100 Å

While doing this exercise, the dimensional proportions involved would come rather lucidly to the learner's mind and he will soon start pondering about the subcellular structures and phenomena. One can well imagine what sort of problems will be encountered, amusements and thrills derived, if one tried to carry this exercise

further to drawing a scaler sketch of a typical cell after learning more about the cell organelles.

### Magnification and Resolution

As already evident, the organisms and their organelles are observed at three levels of resolution which are: a fraction of mm, micron and Å corresponding to the resolving power of the human eyes, the optical microscope, and the electron microscope. With each of the three tools, of course, exists not one definite value but a range. The word resolution and magnification are often erroneously understood and used. Small objects, just visible through unaided eyes, can be photographically enlarged several hundred times. But shall we see any details comparable to what could be seen under an optical microscope? If that were possible, microscopes could have been done away with as tools of observation.

Therefore, the utility of the microscope lies in its property to resolve two close-by points apart from each other and in this the optical microscopes are about 100 times better than our eyes. The magnifying power of the instrument functions simply to bring the points already resolved to the level of the resolving power of the eyes.

Therefore, the magnifying power of the optical microscope is of the order of a few hundred times only. The wave-length of light and the properties of glass lenses do not permit much betterment of the resolving power of the light microscope.

The resolving and magnifying powers of the electron microscopes are based on similar considerations. The best resolutions available in the electron microscope are of the order of a few Å units and the magnification in these works to bring the resolved points on a photo-graphic plate to more than the limit of the resolving power of the eyes, i.e. of the order of few hundred thousands.

## Energy and Cellular Processes

### Why Thermodynamics in Biology?

No one can logically question that for every 'work' to be done certain amount of 'energy' must be spent. "I neither have time nor energy to waste" is a commonly encountered expression among the educated people. The biologists know that the energy-work relation applies not only to machines but also to man and other organisms. For instance, man performs 'work' through his limbs and the muscles inside, the muscles derive energy ultimately from the food consumed by the man. The foods are made of definite chemical molecules and are broken down into other molecules, thus releasing their energy which our muscles use. It naturally follows that the bioenergetics must be conceptualised at the molecular level. The thing to realise at this stage is that basically the apparent expenditure of energy has molecular basis, that energy exchanges do take place during the process of chemical reactions and that no system, physical or biological, is 100 per cent efficient in the sense that all the energy released in a reaction is available to do work, and further, that a part of it always becomes unavailable for doing work (Entropy).

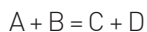
Just as the ultra-dimensions should be clearly visualised for the study of cell biology, simple mental images must also be built to understand the total energy (Enthalpy), energy available to do the work (Free Energy) and the third thermodynamic quantity (Entropy) which is not available for doing work. For a biology teacher these terms and concepts may appear new but the need to understand the energy transfer processes

not only in the cells but also in the biosphere necessitates a bit of effort made in this direction. It is made quite explicit here that in introducing these terms and concepts it has been kept in mind that no prior knowledge of physics or chemistry is required but those having some background would not only find it easier to comprehend but will be able to relate better their previous understanding to its applications in cells.

For the present level of the subject matter, the theoretical discussions, mathematical derivations, and numerical calculations will be avoided. It is only being attempted to help the learner to perceive these thermodynamic quantities as would aid them in visualising the energy transfers, directions of reactions and the irreversibility of the biological processes in the light of these definite physico-chemical principles as being applicable to biological systems.

### Total Energy

As the life processes are now seen as an integrated sum of physico-chemical reactions, we can say that a number of reactions that occur in the protoplasm are made of components like:



where A and B are reactants and C and D are the products of the reaction. As already mentioned, each molecule has its own built-in energy. Hence, when any two molecules react to form any product or products, some energy transfer is definitely involved. If the reactants and products of the above reaction could be taken in isolation and physically burnt to obtain a certain number of calories, for each side of the equation we shall get the total energy content (Enthalpy) for either side of substances. Let us say that (A + B) gives us X

calories and (C + D) gives us Y calories upon combustion, in this way. Then  $\Delta H$  (delta H or change in enthalpy or the heat of reaction, all synonyms) will equal  $Y - X$  calories,  $\Delta H = Y - X$  cal.

### Free Energy

As will be seen in our later discussion of entropy,  $\Delta H$  is not necessarily (ideally never) the indicator for the direction of a particular reaction. In every reaction, a component of it becomes unutilizable to do 'work'. Therefore, the remainder of the energy released in a reaction that is actually available to perform work is termed 'free energy'. It is easy to imagine free energy with the analogy of the potential energy of a body kept at a height from the ground. The potential energy of such a body depends upon its vertical distance from the ground. The stretch of a spiral spring or the voltage of electricity may be other analogies. Although the free energy (F) of a molecule depends on its constitution it is not measurable except, in terms of  $\Delta F$ , or change in free energy in course of a reaction or a process. So, for our example,  $A + B = C + D$ ;  $\Delta F$  is also a measurable quantity. If the  $\Delta F$  (i.e.  $F_{\text{react}} - F_{\text{prod.}}$ ) is a negative quantity the reaction will move spontaneously to the right and useful energy will be available for the performance of work 'by' the system. Such a reaction is known as exergonic reaction. For the reaction to proceed in the reverse direction (endergonic reaction) energy must be supplied from outside, i.e., work must be done 'on' the system.

### Entropy

But as pointed out, not all such energy transfers are one hundred per cent efficient and for each

reaction, a fraction of it becomes unavailable for doing work. The lost energy is due to the intra-atomic movement of electrons, intra-molecular movements of atoms; and intermolecular movements with relation to each other. It follows that the faster the movements the greater will be the unavailable energy.

Entropy is a measurable quantity though difficult to imagine. Besides, in contrast to enthalpy and free energy, it is not an energy form. It becomes an energy form only if multiplied by T (absolute temperature).

$$\text{or, } E (\text{unavailable}) = TS$$

The following example will help us visualise this quantity better. For any well-ordered system or structure, the entropy is the minimum. The row-wise arrangement of desks in the classroom means less entropy than the same classroom completely disorganised by the unruly behaviour of children. Someone has to put in extra work to bring back order to such a disorderly system. If a few of these desks are broken down then a carpenter has to do further work first to reassemble them before the desks could be put in rows again. It would thus mean that larger the number of possible arrangements of the components of the classroom the greater would be the entropy. Further, if some of the desks are damaged to such an extent that even any repair becomes impossible, i.e. if the damage is irreversible, then the increase in entropy is further enhanced. Therefore, increase in entropy is not only associated with *disorderliness* but also with *irreversibility*, increasing in each condition.

#### *The Relationship between H, E, and S*

Being already aware of these three parameters we

can sum up their interrelations as follows:

$$H = F + T \Delta S$$

and  $F = H - T \Delta S$

### **Entropy and Life**

Entropy can also be seen as a philosophical concept not just for the physico-chemical reactions or life processes but any range of socio-economic or political events since order and disorder are common phenomena all around. In the case of socio-economic and political phenomena, the role of administration is to reduce entropy. The living organisms and life processes are often characterized as giving rise to 'negative entropy'. This is by virtue of their being highly regular and orderly. When large number of

amino acids join at random to form a protein molecule of highly ordered nature the system is actually proceeding from larger number of possible assortments to a definite sequence. Here the thought or negative entropy comes into picture. The protein synthesis in cells is the 'key' to biological organisation and function. Similarly, when smaller molecules like water and carbon dioxide give rise to orderly organic molecules, the work must be done on the system, free energy provided and the entropy reduced. The energy of the sun, through photosynthesis, makes it all possible.

The arrow of life moves in one direction, i.e., the direction of time, it is irreversible and the loss of life means increase in entropy.

# PSYCHOTROPIC DRUGS – I

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Drugs are chemicals which affect us physically as well as mentally. In this article, we talk of drugs (both natural and artificial) which modify mental activity in human beings. These are commonly called psychotropic drugs.

Addiction to such drugs means a compulsion on the part of the user to continue the use of drugs. Habituation is the desire to do so.

Drug-taking is an age-old practice almost in every society. But in this article, our chief concern is the weakness among young people and students for the addictive drugs.

Here, we shall try to acquaint ourselves with the various natural and synthetic drugs, and then, with the nature and extent of drug use, the social basis of drug dependency and the contemporary youth culture *vis-a-vis* drug taking.

Contemporary drug use is somehow related to the loss of faith in reason and emphasis on emotion. Such qualities like self-control, planning and patience are grossly devalued. Past and future have become meaningless to many; the reason for living is sought within present experience, here and now. The motivational patterns behind drug addiction, however, vary from drug to drug and person to person. It is not enough to know that our young friends become drug addicts. Perhaps it is more important to know why they become so. Weakness towards psychotropic drugs is neither born in a social vacuum nor can it be explained in terms of a group or individual viewed in isolation from the rest of the society.

Potential addicts in the society outnumber the actual addicts. It is the opportunity, social and family set-up, friends and companions, mental make-up and personal proneness that convert one to a drug addict. Addiction may frequently develop from simple adolescent curiosity. Thus, there may be a wide variety of background stories that lead people to drugs. There is often a particular type of dependence in a particular society. Barbiturate dependence, for instance, is rather common among the urban youth. The supply may be available from a variety of sources— through under-the-counter sale to stealing from hospitals or through forged prescriptions.

Much of amphetamine abuse is also very common. Many young men start with drugs to get what they call a “kick” and to earn a temporary relief from routine life. Others start taking drugs to keep awake at night during or before examinations. By and large, to immature minds, drug-taking has become a part of new enlightenment. Willingly or out of ignorance, they remain blind to the knowledge of real dangers

involved. Excitement and adventure, delinquency, peer group pressure, seeking of hallucination or curiosity play their roles. Those who find solace in drugs to avoid personal frustrations and depressions find in drugs a means to release tension. One may get initiated through friends who describe how good it makes them feel. Inspired by friends and peer groups, a school goer starts with drugs and gets a sense of graduation to be a part of the 'in crowd'. Some think that the drugs would take them to another world where "the doors of perception" are open and their capabilities to appreciate aesthetic experience are heightened. Some drug-takers like to believe that drugs lead them to intellectual enlightenment and creativity. Occasional pill-taking and cannabis smoking are gradually becoming common for young people. Many of them want, through drugs, a relief or change in mood or feeling.

Any survey of drug-addicts in our country would show that the latter have had problems and difficulties which they were not able to face. A lot of beginners, however, start on their own just to know how many 'pills' to take to get the 'desired' effect. Friends, classmates, the students' own 'society' exert pressure on them to participate in what they are doing. This is a general picture in every country, every society and community. One must keep up with the others at any cost. If an individual wants to be 'fit' for a group, and the group takes pills, or smokes hashish or marijuana, the individual has to give in to the majority.

An analysis of the problem of drug addiction leads us to the conclusions that:

(a) drug dependence is increasing throughout the world;

(b) forms of dependence show variation with cultures;

(c) with every form of increase, there is an increase in lawlessness, violence and crime;

(d) the disease is preponderant among youth.

### Primary natural products

Before we deal with the common, commercially available drugs, we have here a summary of primary natural products and some of their immediate derivatives.

Opium has been extracted from the poppy plant, *Papaver somniferum* for hundreds of years.

Opium was prepared by the Sumerians 5,000 years before Christ. The plant is cultivated in India, Persia, Turkey, China and South-East Asia. Opium is prepared from unripe capsules of poppy plant. The milky juice is dried to a dark brown cake before it is used. Once, China had been the proverbial victim of opium addiction.

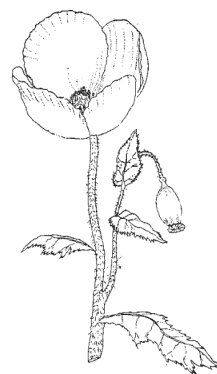


Fig. 1: Opium Poppy

Opium is both eaten and smoked. The poppy capsules are soaked in water and the water is subsequently taken as a beverage. Raw opium is taken orally. This is consumed mostly by poor and labouring class. Consumption is relatively high in Assam, Orissa, Punjab, West Bengal and Madhya Pradesh.

Morphine is the main alkaloid derived from opium and is taken in the form of injection. This was a wide abuse once; presently, it has been effectively



replaced by Heroin which is derived from it synthetically.

Heroin is the most dangerous drug among the narcotics (i.e., drugs which depress the activities of the brain and the central nervous system). Codeine is another derivative of opium. Certain codeine-containing tablets induce slight dependence and are widely used in many countries.

The immediate response to opium is reduced respiratory and cardio-vascular activity, constriction of the pupils, reduction in visual acuity and, in some cases, nausea and vomiting. Toxic overdose of opium may lead to respiratory arrest and death.

The versatile hemp plant *Cannabis indica* is called *bhang* or *ganja* in India, *khif* in Algeria and Morocco, *takrouri* in Tunisia, *hashish* or *kahif* in Lebanon and *marihuana* (marijuana) in other parts of the world. The word 'hashish' owes its origin to the name of an eleventh century Persian

*brotherhood—hashshashin*. Addicted to hashish, the members of this secret society tortured and murdered their religious rivals. The word *assassin* also comes from the same source.

Use of cannabis drugs is widespread throughout India, Pakistan, North Africa and the Americas. In this country, *bhang* (or *siddhi* or *patti* or *sabji*), *ganja* and *charas* are obtained from the hemp plant. They differ from each other in methods of preparation and types of plants or plant parts



Fig. 2: *Cannabis indica*

used for preparation. Dried leaves and flower shoots of male and female plants make *bhang*. *Ganja* is obtained from the flowering or fruiting tops of hemp plant. *Charas* (or *hashish*) is chiefly the resinous matter collected from the leaves and flowering tops of female plants. Marijuana is derived from the top of *Cannabis sativa*, a closely related species. The effects of *hashish*, however, are more potent than those of marijuana. Both of them are smoked. Amongst the student community, most of the cannabis products are smoked in the form of cigarettes. The tobacco content of the cigarette is usually taken out and in its place is put the cannabis product.

Our knowledge of the psychological and physiological effects of hemp drugs is rather incomplete. Marijuana is possibly not addictive but it can cause severe psychosis. In naïve subjects, cognitive functioning obviously decreases. Often marijuana addiction is the first step towards heroin addiction.

Smoking of hemp plants causes simple psychomotor dysfunction. Immediately after smoking, there is an increase in frequency of urination, dilated pupils and an increase in blood sugar level. Unlike the opium (or cocaine) addicts who seek solitude, the cannabis users enjoy the company of others.

Cocaine is derived from the leaves of the coca plant, *Erythroxylon coca*. (It has no connection with the source of cocoa.) The plant does not grow in India; it grows abundantly in Peru, Bolivia, Columbia and Java. Cocaine has gained popularity because of its anaesthetic and euphoric effects. Chewing of coca leaves is an old practice in the Latin American countries. It relieves fatigue and mental depression at lower doses. As a stimulant,

it induces talkativeness and feelings of increased energy. Other common feelings are sleeplessness, complete loss of appetite and hallucinations. Prolonged use of cocaine causes impairment of mental function.

The comparatively recent habit of taking cocaine with heroin has been widely popular as the HC habit. However, the use of cocaine alone is fast disappearing. Stimulating effects of amphetamines, which are far more easily available, are more preferred. Misused cocaine may cause convulsion or even death due to cardio-vascular or respiratory failure.

*Khat* is obtained from an Ethiopian plant, *Catha edulis*, a common shrub of north-east Africa. The plant is also grown in Karnataka and Maharashtra. Fresh or dried leaves are either chewed or taken in



Fig. 3: Coca plant

the form of infusion. It is a strong stimulant that reduces hunger and, on prolonged use, numbs the intellectual faculties.

The peyote (or peyotl) cactus *Lophophora williamsii* grows wild in Mexico and Texas where people have chewed the roots of the plant since olden days. This is also taken in an infusion- "peyote tea", as they call it. Peyote contains an alkaloid called mescaline, the effects of which have been described by Aldous Huxley in his *The Doors of Perception*. Mescaline is sold in the underground market in powdered or liquid form and is usually taken orally. A strong hallucinogen, mescaline is a potent substitute for LSD.

Psilocybin is derived from a Mexican mushroom, and like mescaline, it has been used by the Mexican Indians for hundreds of years. Properties of the drug are very similar to those of mescaline or LSD.

In the French Equatorial Africa, people chew the root of the shrub *Tabernanthe iboga*. The active chemical ibogaine has psychedelic effects.

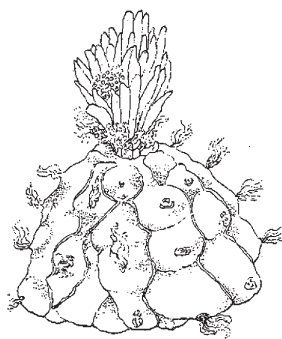


Fig. 4: Peyote cactus

# PSYCHOTROPIC DRUGS-II

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### Some Synthetic Drugs

Most of the drugs we are going to talk about now are synthetic products.

Hoffman, a Swiss chemist, was working on substances derived from the ergot fungus and quite accidentally found out that ergot contains lysergic acid, the precursor of now well-known LSD. The term LSD has been derived from the German term for D-lysergic acid dimethylamide 15—a strong hallucinogenic compound. The discovery of lysergic acid stimulated its medical use as a therapeutic aid. Its subsequent success in medical use may be doubted, but LSD was promptly picked up by drug-takers. Colourless, odourless and tasteless, LSD is one of the most widely used drugs today. Easy to manufacture and distribute. LSD is taken orally or sniffed or even injected into the body (in the form of solution). It is available in capsules or tablets, often mixed with food items, to hide it from public notice. In the Western countries, one of the common methods of passing around LSD is mixing it with the gum of postage stamps—a little amount provides a full reaction.

LSD induces various effects—fear, tension, depression, vision of beautiful colours, fantastic pictures, kaleidoscopic colour effects or a sense

of unity or “cosmic oneness” with the universe. LSD often leads to chronic psychosis and severe damage of the central nervous system. The drug has been reported to damage chromosomes of the user. In extreme cases, offspring of the user are born with fatal abnormalities.

There are several other drugs which are as dangerous as LSD or may be even more. DMT (dimethyltryptamine) and DOM (dimethoxy methamphetamine) are examples. Prolonged use of DOM or attempt to quieten the addict with largactil has caused death on many occasions.

Among the milder drugs, amphetamines (popularly called “Pep-pills” or “Speed”) and the related groups induce stimulations as do caffeine and cocaine. The stimulants in general suppress appetite and increase activity, alertness and tension. In higher doses, they cause sleeplessness. Tobacco (nicotine) is used as a physiological stimulant. Caffeine, in low doses, is a socially accepted stimulant taken in the form of cola drinks, coffee or tea.

Sedatives are mostly barbiturate drugs. Hundreds of barbiturate drugs have been synthesised and regular consumption of barbiturates is only commonplace today. They reduce anxiety and tension, and at higher doses, induce sleep. Taken with alcohol, barbiturate drugs may be fatal.

Tranquillizers are still another group and have tended to replace barbiturates as day-time sedatives.

A peculiar habit of inhaling volatile solvents like toluene, acetone, ether or chloroform has been developed in recent time. They are inhaled from commercial products that contain them and seem to have mild hallucinogenic effects. The habit goes often unnoticed.

The above, however, is rather a brief list of drugs which are commonly abused. The range of actually abused drugs is longer. There are several drugs used in different places which are typically local inventions. While many of the above drugs have legitimate medical use, most of the barbiturates and tranquillizers are widely used as addictive substances throughout the world.

Now, the young people's weakness for these drugs needs a special consideration, in the light of prevalent youth cultures. There is not one homogenous youth culture in our country; it is a series of overlapping cultures varying with social or economic classes and educational levels. In the urban areas, where drug-taking among the youth is prevalent, young people are somehow hived off from the rest of the society. They are placed in special category between the child and man. The teenager with a middle class background has a rather long period of ambiguous status compared to a working-class youth. He is not engaged in productive labour and is discouraged from early marriage. He is not allowed to loaf around but may be engaged in proto-courtship. He enjoys certain privileges and individual freedom but has no obligatory ties. Majority of them adopt the role that adults expect them. Deviation, however, exists, though 'conspiracy of silence' minimises apparent conflicts. This minority dissociate

themselves from the conformist line. Some of them engage themselves in illicit activities; they create their own world where social control is minimal.

The delinquent youth culture centres itself around the various available ways of creating, for itself, a world of adventure, hedonism 'kicks' and excitement. One of the activities which provides both excitement and pleasure is the use of illicit drugs. This may be a vehicle for the emergence of subterranean values and a method of seeking forbidden pleasure.

In the Bohemian culture, the use of drug is exalted to a position which is completely buttressed against the criticisms of the outside world.

Not much is known about the pattern of drug-taking in our country. Limited information on urban areas indicate that the highest percentage of young drug-takers primarily begin this habit because of various kinds of maladjustment and, secondly, to be 'in' with the friends. Frustration, failure, anxiety are also causes of drug-addiction. The first acquaintance with drugs, however, are through friends.

Distribution of students according to types of drugs shows that most people prefer, or depending upon the availability—made to prefer *charas*, hashish, marijuana, Mandrax or LSD. The other types are various commercial varieties of amphetamines or barbiturates. Mandrax, especially in the eastern part of the country, is a widely used tablet. Comparatively cheap, it is a tranquillizer which produces pleasurable sensation. Effect of one tablet in empty stomach is instant and is similar to that of hard alcoholic drinks (without the characteristic smell). The habitual users keep themselves without food for a

long time and then take the tablet in the evening to get a strong kick.

Survey findings from large cities show a rather alarming picture. Quite a large number of students start taking drugs from their school days. Identification of these users is a formidable problem, because the students who take drugs are extremely secretive. Slightly upwards of fifty per cent addicts confess that they had started taking drugs from the age of seventeen to nineteen. Around twenty-five per cent start even before seventeen and another twenty five per cent after nineteen. But the important question is how to find out these young addicts! The extent of addiction in the student population cannot be made out easily. Though change in appearance and behaviour of a person sometime help in identifying him as a drug-taker, in most cases it is not an easy job.

Some indicators, however, often help identify an addict. He may feel drowsy and sleepy in the day time; may appear to have lost control over himself (without the smell of alcohol) or may have needle marks on the skin. Many drug-takers always try to isolate themselves at regular intervals and all of them are in constant need for money.

The majority of young people are, however, not victims of drug-addiction but why somebody is not an addict it is very difficult to answer. Survey data show that the majority do not take drugs because they have no inclination or they do not see any need to try a harmful thing. A good percentage do not go in for it because they 'are afraid', others avoid drugs because they do not want to hurt their parents.

Those who do not want to see the problem of drug-addiction as an isolated issue are concerned

with the question—why does an alarming number of young people become drug-takers? It is a serious question, for the whole way of life of the addict, his relations with the family and society, rather than LSD or marijuana, give birth to many a tragedy. The consequence of drug-addiction is itself a grave matter, but the correlation of drug abuse with large-scale anti-social behaviour is an equally serious issue. Acts of aggression and violence originating from illegal drug traffic take no lesser toll than severe cases of individual addiction. Vandalism and arrogance are too common among drug users in the schools and colleges. Because most of the widely used drugs are contraband articles, the user has to get involved in illegal traffic. Drug-taking is like an infectious disease and the addict is a sick person. He does not have the right to endanger the physical and mental health of the rest of the community. A sick person should get adequate treatment and sympathy of the society. But strict preventive measures are more important. They are connected with the external circumstances on one hand, and the internal circumstances on the other.

Were drugs not available in the unauthorised market, buyers would not get them. Under the counter drug selling in the urban chemists' shops should be prevented with utmost severity. Some people suggest that the youngsters be kept away from the knowledge of drugs and that frequent discussions about drugs in newspaper articles and magazines induce young people to experiment with drugs. There is some truth in it. But sooner or later many of them do come in contact with drug users and some of them may follow them unknowingly. And in those cases, ignorance of the problem will be a greater danger.

The internal circumstances involve the background environment of potential addicts. Young boys and girls learn some standards and ethics from the elders. As they grow up, they might discover instances of “double standard” among the elders; this often alters the sense of values.

A word or two on the treatment and cure of drug addicts.

Treatment of drug-addicts should be undertaken only by a qualified physician. A positive treatment programme may include control of the source of supply of the drugs, withdrawal from the drugs, assessment of psychological difficulties and after-care and rehabilitation.

Control of the source of supply is the most important step; so long as the drugs are available,

it is almost impossible to withdraw the patient from the drugs.

The process of withdrawal applies well in case of drugs which create psychological dependence. Psychological dependence needs psychological solution.

Once withdrawal is established, psychological difficulties may be identified. The period of after-care is important. The majority of relapse cases are due to inadequate after-care. Many patients return to their old habit because there is nowhere else for them to go. Mere medical treatment is not enough for the real problem is not the drugs—they are only a symptom. It is not enough to cure the addicts—the addicted society needs to be cured. Addicts are terribly lonely people—we should not reject them.

## A GODDESS DEFIED

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*"Often, before uneducated villagers would agree to submit, the vaccinators would have to jab themselves in front of the entire community, to prove that there was nothing harmful!"*



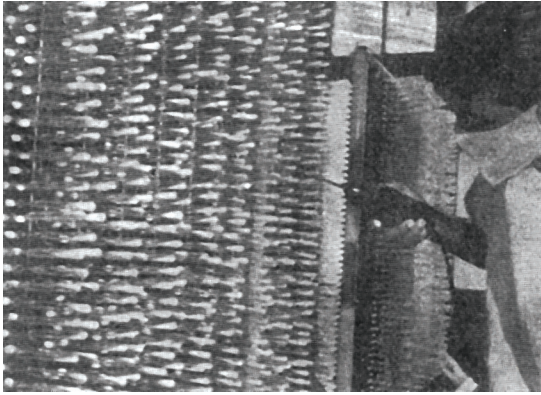
Late in May 1975, at the sleepy little eastern border town of Karimganj, Indian smallpox field workers zeroed in on the railway station and successfully isolated a victim of the disease —Saiban Bibi, aged 30, a woman migrant from Bangladesh. That was the last time any of the several thousand people employed by India's Smallpox Eradication Programme had occasion to use their skills.

It had been far from smooth sailing, and at the outset there was a critical shortage of manpower. Mr. L.R. Tiwari, a former vaccination inspector who spent 20 years combating smallpox told me: "Before 1960, Delhi with 2.5 million people had just one vaccination superintendent and 35 vaccinators (and the capital has always been more fortunate than the rest of the country). When the smallpox pilot project was started in 1960, staff strength was raised to 37 inspectors and 176 vaccinators. This permitted a door-to-door survey of the entire population and every individual got his or her primary vaccination".

But the primary task was not so much reaching individuals as overcoming ignorance and prejudice. *Shitala Mata* has for centuries been worshipped as the goddess of smallpox, and temples dedicated to her are dotted around the country. Some devotees believed she spilled grain from a basket on her head every time she shocks it, and each grain turned into a smallpox pustule. Victims survived if she used water from the pitcher in one hand to clean the spilt grain, but did not survive if she used the broom which was in the other. Some people worshipped smallpox cases as being blessed by the goddess. Relatives and friends would come miles to pay homage—and merely succeeded in spreading the infection.

So it was not surprising that many refused to be vaccinated against what was considered to be the goddess's generosity. Another vaccination inspector, Aman Hussain, recalled: "When we first went into the field, people got agitated and soon became violent. The police had to intervene". But that solved few problems.



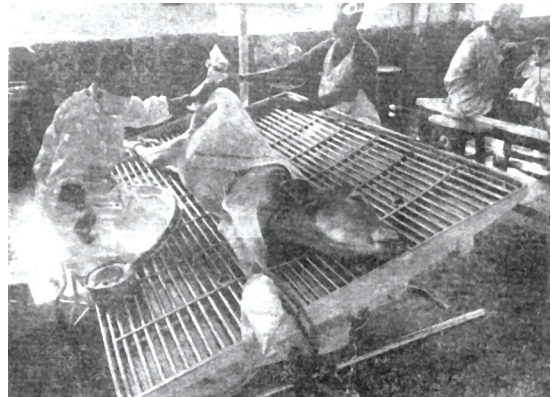


The “bullets” that helped to exterminate a killer disease. Serried ranks of freeze-dried vaccine doses in an Indian Laboratory

“The people were agitated about the vaccine, which was believed to come from the cow and was therefore against the Hindu religion”, said Mr. C.B. Sharma. “Religious groups like the influential business-oriented Jains and the Namdhari Sikhs even started heated campaigns against it. Villagers claimed that their kids died following vaccinations, and undoubtedly some did. However this was because they would rub cow-dung on the fresh vaccination, thus causing tetanus. Or they would immediately suck- out the vaccine. But the blame was invariably put on the vaccinator, who received an extremely hostile reception whenever he returned”.

Often the vaccinators would first have to jab themselves in front of the entire community, to prove that there was nothing harmful. Mr. Tiwari himself did not campaign. But the remark: “I had to give myself smallpox vaccinations four to five times a year. And every time it worked. We would persuade freshly vaccinated cases to stand around for 15 minutes so the vaccine would dry, and we

warned them of the grave consequences of applying cow-dung. When protected kids didn’t die in any of the post-1959 smallpox epidemics, opposition to vaccination faded away. There has been no smallpox in those villages and slums for the last 20 years, even though some devotees to *Shitala Mata* began worshipping the inflamed vaccination scab on the eighth day!”



Freeze-dried vaccine being prepared from virus grown on the skin of a living animal — a calf

Over the years, conditions and awareness throughout the country underwent a sea change. Back in 1958 it would take hours to persuade just one man to take his shot. Field workers would travel miles to track down a case, who might be carried from village to village just in order to dodge treatment. “Today when we go into the fields, we’re welcomed”, Dr. N.K. Gupta, Delhi’s Medical Officer for Communicable Diseases, said with evident satisfaction.

Most crucial to eventual success was the new WHO strategy implemented from 1973. Rather than vaccinate every individual—an impossibility with 650 million people—it was decided to concentrate available resources on areas with

smallpox cases. Detection was a critical feature, achieved largely through publicity, with the offer to rewards for anyone finding a sufferer, and house-to-house searches for cases of fever with rash.

“We have now started taking immediate containment measures on the report of any case of infectious disease”, Dr. Gupta told me. “Patients are removed by flying squad to the Infectious Diseases Hospital and their homes and surroundings are immediately disinfected. Anyone who came into contact with the case and those living around are given prophylactic

immunisation. The area is investigated to find out any source of infection or any additional case. We wait and then try to delimit the area in the event of secondary cases”.

In the light of long years of experience in the field combating smallpox, what would the field workers do to contain the menace of infectious diseases? They unanimously acclaim the measures spelled out by Dr. Gupta—not for the sake of agreeing with a superior, but out of a genuine belief in the superiority of the successful WHO strategy.

Courtesy: WHO

# CANCER: ENVIRONMENTAL AND HABIT-LINKED CAUSES

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Cancer today is one of the most dreaded diseases the mankind has been suffering from. It is, in fact, a collection of diseases that take a heavy toll of human life. At present, one-fifth of the total human deaths in the world is due to cancer. This situation has compelled thousands of cancer researchers to undertake strenuous round-the-clock research to investigate the definite causative organisms or the causal factors behind more than a hundred types of human cancer.

### What is Cancer?

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Cancer can be described simply as unrestrained and unrestricted proliferation of body cells. All types of tumors are broadly classified into two groups—benign tumors and malignant tumors. When the unrestrained multiplication of cancerous cells remains confined within a very restricted area of the body, it is called benign tumor. Such tumors, though sometimes prove to be fatal, can usually be removed surgically. In the malignant types of cancer, the cancerous cells often invade through the circulating blood and lymph from their sites of origin and reach distant organs and systems. Such dissemination process of malignant cells is called 'metastasis'. It is often

found that it is not the original tumor but such metastasis that becomes the ultimate cause of death. In some types of malignancies, the spread of the cancerous cells to different other organs and systems is so fast that even after early detection, all attempts at treating the patients surgically, chemotherapeutically, or radiotherapeutically are often proved to be futile.

### What Causes Cancer?

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Getting cancer in the body depends very much on the personal, social and cultural habits of man. Like many other diseases, cancer is primarily a product of the interactions between man and his environment. That is why cancer is often described as an insidious environmental and social disease. A large majority of cancer experts claim that almost 70 to 90 per cent of different types of human cancer is normally induced by various environmental factors, and, as such, at least theoretically, it can be avoided through conscious efforts.

Many of us are already aware that consumption of tobacco and alcohol, presence of some pollutants in air, water and soil; diets and dietary habits; toxic

industrial chemicals; prolonged exposure to sunlight and ionising radiations promote the incidence of cancer in human populations. Although people living in highly urbanised industrial centres are more vulnerable to the disease as a result of polluted environment, people living even in the remotest rural areas are also susceptible to it due to environmental factors and/or personal habits. The recent increase in the incidence of this disease among the people living in industrialised cities as well as rural areas is due mainly to the phenomenal and unplanned growth of chemical and other industries and indiscriminate use of chemicals which have not been properly tested for carcinogenicity (i.e., cancer-inducing properties). Among other factors, changes in eating and personal habits have also contributed to the incidence of cancer.



**Many chemical pollutants of the environment can promote incidence of cancer**

Some industrial chemicals, drugs, pesticides, tobacco smoke, cosmetics, etc., have been proved to contain cancer-inducing substances. These

\*1 Russell Train, *Testing Chemicals, Not People*

substances are known as carcinogens. Russell Train, former Chief of the Environmental Protection Agency remarked: 'There are today more than 30,000 chemicals in actual commercial production; every year, this list grows by some 1,000 new compounds. Of the more than two million known chemicals, only a few thousand have been tested for carcinogenicity and—aside from those used in food additives, drugs and pesticides only a few hundred have been adequately tested. We know, in fact, very little about the health effects even of the 30,000 chemicals already in commercial production. We have no way of systematically screening the chemicals that do go into production; we have no way of knowing precisely which chemicals go into production every year. In other words, we not only don't know whether what's going out there is dangerous—we don't even know what's going out there.

We have, however, learned one thing: 'it's what we don't know that can really hurt us, even kill us.'<sup>1</sup>

Therefore, to avoid contracting cancer through environmental exposure to carcinogens, one has to be extremely cautious and obey "do's" and "don'ts" the cancer specialists have continuously been announcing to save human life from the clutches of this dreaded disease.

## Some Major Causes

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Surely if one counts the environmental and habit-linked causes and promoters of this disease, it will be an alarmingly long list. The general public awareness of these causes and promoters of various forms of malignancies is the urgent need

today. Such awareness will enable us to rectify our personal, social and cultural habits to curb the disease. Let us discuss some major causes which are either proven or suspected causes of different forms of cancer.

### **Industrial Chemicals**

A large number of industrial chemicals which include food additives, cosmetics, dyes, drugs, asbestos, chemical constituents of plastic, etc., can induce different types of human cancer. Evidences as available from different countries of the world have almost conclusively proven that indiscriminate use of many such substances escalates the incidence of the different types of this disease. A few examples of chemical substances which can definitely cause or promote cancer are discussed here.

#### **Asbestos**

People working in asbestos factories inhale asbestos dust and minute fibres for a prolonged period of time. As a result, many of them have been seen to contract a rare and fatal cancer of the chest and abdominal lining (mesothelioma). This has become a major health problem among asbestos factory workers in the United States. Often, the disease is detected at a very late stage and the conventional treatment fails to cure it. It has been observed that the asbestos residue on talc-coated white rice could also induce cancer. Unfortunately, Japanese are fond of such rice in their meals.

#### **Vinyl Chloride**

It is a chemical constituent of plastic. It induces a rare form of liver cancer. During the 1970s, a large

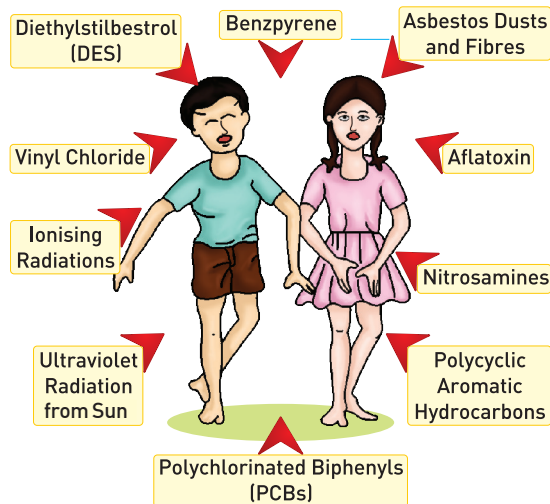
incidence of this form of liver cancer among the workers engaged in plastic industries around the world was reported. Experts made no mistake in identifying vinyl chloride as the inducing agent for this disease.

#### **Diethylstilbestrol (DES)**

It is a proven carcinogenic drug. During the last decade it had created a major health hazard in the form of vaginal cancer in more than hundred young women in the United States. Investigation revealed that mothers of these young women had taken this drug during pregnancy, in the belief that it helps prevent natural abortion.

Since the 1940s, American physicians had prescribed estrogen DES to a vast population (between five hundred thousands and two million) of pregnant women in the United States. The physicians did it in the erroneous belief that this hormonal drug helps prevent spontaneous abortion. Surprisingly, even after the investigation that the drug failed to prevent abortion and that it had carcinogenic effects on the foetus, it was being administered to a large section of pregnant women till the early years of 1960s.

In addition to the three examples given above, a kind of aromatic amine once used in hair-dyes, arsenic in air, chloroform in drinking water and cosmetics, PCBs (polychlorinated biphenyls) in mothers' milk and fish are some of the causal factors of this dreaded disease. The list of chemicals inducing cancer lengthens alarmingly almost every week.



Some of the known cancer-causing chemicals and physical agents

### Dietary Habits and Food

Recent findings clearly reveal that some dietary habits and food promote the development of cancer in man. Whether a person stands a chance of getting cancer in his body depends very much on his dietary habits and the types of food he consumes in his regular meals. Specialists hold the view that there are some dietary components, though they themselves are not carcinogenic, probably act as causal factors for the production of carcinogens in the body. Let us discuss here a few known examples of the incidence of the disease where dietary habits or food items play the role of inducers.

#### Fat-rich Diets

The excessive consumption of even ordinary fats in the everyday meals brings about the hormonal, as also digestive, changes which in turn cause this

disease. Regular intake of fat-rich diets is suspected to enhance the chances of getting several malignancies like cancer of the breast, the bowel and the prostate glands.

#### Smoked Fishes

The smoked fishes consumed in abundance by the Japanese people every year vulnerably expose them to the chances of contracting stomach cancer, as smoked fishes contain polycyclic aromatic hydrocarbons. These chemicals had already been proved to be carcinogenic in some other contexts. Not only in Japan but also in other countries where people consume a large amount of smoked fish, a high rate of the incidence of stomach cancer has been reported.

#### Nitrosamines

Nitrosamines, the chemical substrates which get synthesised within the body, have recently been suspected to be the major causes of stomach cancer. Formation of nitrosamines in the body is believed to depend much on the amount of nitrite and nitrate intakes through food and water. Salivary nitrates also often transform naturally into nitrite. Nitrite can enter into chemical combination with certain foods or drugs to form nitrosamines.

#### Aflatoxin in Food

Aflatoxin, considered to be a highly potent dietary carcinogen, is produced by molds grown on some types of human food (i.e., grains, peanuts, etc.) has been proved to be a known promoter of liver cancer. Food being contaminated by aflatoxin has been linked up with the world's highest incidence of cancer in parts of Africa, Thailand and the Philippines. Aflatoxin-related cancer hazard has alerted food inspectors who have now become

more vigilant to detect each and every aflatoxin contamination of food so that such contaminated food items do not reach up to their consumers.

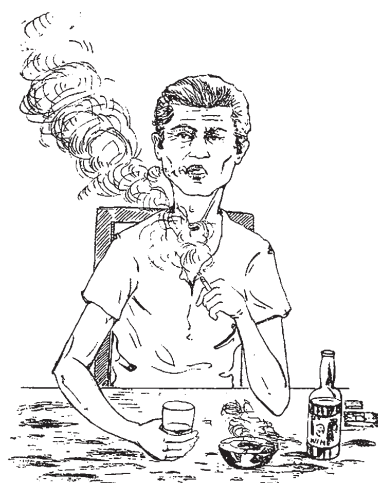
Nobody knows for certainty how many chemical substrates we consume in our food are linked up with this dreaded disease. Undoubtedly, the cancer caused or promoted through dietary habits and diets is a greater environmental and social problem than any other type promoted or induced by other factors.

### **Tobacco**

Tobacco-smoking is a much talked-about and widely known promoter of lung cancer. A considerably large human population falls victim to the disease and dies prematurely. Since, globally, a much higher percentage of male than female population includes habitual smokers, the males are the worst sufferers. Studies have revealed that persons who regularly smoke cigarettes stand at least ten times more chances than the non-smokers to develop lung cancer. Tobacco smoking combined with air-pollutants and other toxic chemicals which commonly fill the air in factories often expose the workers to carcinogens.

Besides the lungs, the other organs and systems of a heavy smoker also become cancer prone. Tobacco smoking also increases the chances of developing the disease in the mouth, the throat and the voice-box. The chances of contracting this disease are much more if, incidentally, the smoker is also a heavy drinker. Added to it, cigarette smoking increases considerably the chances of getting this dreaded disease in the oesophagus the pancreas and the bladder.

Dr. Gio B. Gori, an expert at the U.S. National Cancer Institute, has already estimated that “people smoking two packs of cigarettes a day for a year expose their lungs to nineteen times more benzpyrene—just one of the possible carcinogens in cigarette smoke—than they would by breathing the polluted air of Los Angeles for a year”. The President of the American Cancer Society held the view that simply by stopping tobacco-smoking the world can avoid about 15-20 per cent of deaths due to different forms of the disease in the United States and many other countries. He held such view only after considering the varied types of cancer and their known causes.



**By combining the habit of smoking tobacco and drinking alcohol a person becomes twenty-five times more prone to develop oesophageal cancer**

### **Alcohol**

Alcohol, many experts believe, does not promote cancer as such, but decidedly increases the fury of carcinogens taken in the body along with other substances. It is now a known fact that by combining the habit of drinking alcohol with



smoking tobacco a person becomes vulnerable to far greater chances of contracting oesophageal cancer. Data available from the United States reveal that the moderate smokers who drink alcohol heavily are twenty-five times more prone to develop oesophageal cancer. It is also believed by experts that almost two-thirds of cancer is caused by the combinations of tobacco and alcohol consumption, and such incidences can be successfully prevented by simply giving up the smoking habit.

Traces of nitrosamines, which are considered to stimulate the development of cancer, have recently been detected by the U.S. specialists in popular brands of scotch whisky and some foreign brewed beers. However, the experts do not know what amount of nitrosamines in these drinks may cause cancer. Tests on other alcoholic drinks, such as bourbons, ryes and liquors, vodkas, rums and brandies failed to detect any nitrosamines.

### **Ultraviolet Radiations from the Sun**

The ultraviolet radiations we receive through sunlight is an important promoter of skin cancer. The light-skinned people are more susceptible to ultraviolet rays of sunlight to develop skin cancer, than the dark-skinned people. People who work in the scorching sun for long durations stand more chances to develop skin cancer.

In the United States and many other countries skin cancer is very common. But fortunately most of these incidences get cured usually due to some intrinsic functions of the body. Melanoma, a cancerous condition of skin often turns fatal. It takes about five thousand lives annually in the United States alone. It has been observed that the incidence of skin cancer is the highest among the

white people who live close to the equator. To get the skin tanned, sun-bathing is very popular among the light-skinned people. This practice enhances the incidence of skin cancer, specially the melanoma, due to the intense exposure of the bare parts of the body to the ultraviolet rays of solar radiations. The ultraviolet rays which induce skin cancer get partially filtered by the ozone layer of the atmosphere before reaching the earth. The apprehension of the scientific community about the potential depletion of the atmospheric ozone envelope, if proves to be a reality, will further increase the incidence of skin cancer globally.

### **Ionising Radiations**

Ionising radiation, involving nuclear reactions, medical X-rays and naturally occurring radioactive elements, are posing much more serious threats to mankind than the ultraviolet radiations of solar origin. Such radiations induce different types of cancer, and can bring about genetic changes (mutations). The scientific community with full awareness of the hazardous effects of radiations has drastically reduced the levels of permissible exposures to such radiations in the recent years. As a matter of fact, it is not yet fully known which particular dose of radiation received by a person at a time, or in fractions spreading over a prolonged period of time, may be hazardous in terms of contracting the disease.

Indiscriminate or frequent clinical uses of X-rays for the purpose of diagnosing various diseases entail major health risks. Five to ten per cent of the incidence of cancer among children in North America and Western Europe during the 50's and 60's was suspected to be due to X-ray exposures mothers received during their pregnancy. In the year 1964, a WHO Expert Committee had

recommended the need for massive reduction of the medical doses of X-rays. But unfortunately even today exposures to X-rays for medical purposes quite frequently exceed the desired intensity. The faulty X-ray equipment and the callous operators often become the reasons for overexposures. Since X-rays are a known promoter of cancer, even for a medical purpose, a person should get X-ray exposure only when it is absolutely necessary.

With the technological advancement, the nuclear power is now being tapped to harness electricity. This has added to our environment a new source of ionising radiation. The nuclear power system, even after all possible care, leaves enough chances of getting ourselves exposed to the radiations. We should always remember that uranium and plutonium used in nuclear power plants are deadly radioactive elements. Many people apprehend that, by the turn of the century, the continual worldwide growth of nuclear power production system and testing of nuclear weapons would increase, many times, the probability of nuclear pollution of the environment. This would probably result in several hundreds to tens of thousands of deaths globally every year due to radiation-induced cancer. Of course, the magnitude of the radioactive pollution of the environment and its problems would depend much on the magnitude of the radioactive leakage from nuclear power plants and the release and disposal of nuclear wastes.

### **Virus and other Infection-related Induction of Cancer**

For quite sometime, many experts in the field of cancer research have been suspecting that some

viruses seem to play a role in inducing at least some kinds of cancer. More than forty different viruses have already been identified which are capable of producing tumors in different animals. No kind of human cancer, however, is known to have been caused directly by viruses. Recent findings indicate that other factors influence the onset of some kinds of human cancer to which viruses are thought to be linked.

A person's susceptibility to a particular type of virus, which seemingly promotes a type of cancer called Burkitt's lymphoma, may increase if he suffers from chronic infection of malarial parasites. Many cancer experts believe that the role played by viruses in the initiation of some other types of human cancer, such as cancer of the lymph nodes, the cervix, etc., will be eventually confirmed.

### **Conclusion**

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The chances of falling a victim to one or other form of cancer can decidedly be minimised, if we cultivate desirable personal and social habits. To cultivate anti-cancer habits in our day-to-day life, we have to make sustained conscious efforts. Specially in a country like ours where a rigorous survey to detect cases of varied forms of cancer and the size of population exposed to the different environmental and habit-linked causes of cancer has yet to be undertaken, there is an urgent need to launch an intensive campaign to create more and more public awareness of the causes and preventive measures to fight the disease.

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# BOSE AND RAMAN'S WAYS IN THE CLASSROOM: DEMONSTRATING THE DEATH OF PLANT CELLS AND MAGNETS

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Living cells have specific structural organisation which in turn is a reflection of molecular configurations. Heating beyond a limit destroys that organisation causing death. Pasteurisation, which is the process of sterilisation by heat, has been possible because of this reason. Molecular configurations of most of the germ cells are damaged severely above a certain temperature. So the germ cells die.

Science cannot be learnt (or taught) just by reading or discourse. Science can be learnt only by doing and by observing. Hands-on experiments and classroom demonstration are part and parcel of science teaching. All through the history of modern science, good teachers and scientists supplemented their lectures with practical demonstrations. Even in the early days of modern science in India, pioneering scientists innovated classroom demonstrations. In this respect, Jagadish Chandra Bose (1858-1937) and Chandrasekhar Venkat Raman (1888-1970) marvelled.

J.C. Bose was a Professor of Physics at the Presidency College, Calcutta for more than thirty years. C. V. Raman was also a Professor of Physics in the University of Calcutta for almost twenty-five years.

## J. C. Bose

Jagadish Chandra Bose is commonly known as J.C. Bose. He was born on 30 November, 1858 in East Bengal, now Bangladesh. After doing B.Sc. from the St. Xaviers' College in Calcutta he went to England for higher studies. He completed his tripos examination from the Cambridge University in 1884. Simultaneously he obtained B.Sc. degree of the London University. He came back to India and joined Presidency College as Professor of Physics in 1885. *He retired* in 1915 but stayed there for two more years as *Professor Emeritus*. In 1917 he founded the Bose Research Institute (Basu Vijnan Mandir) in Calcutta for higher research. He was the *Director* of the Institute till his death on 23 November, 1937.

J.C. Bose started researches in small radio waves. The field is now called micro-wave physics. Indeed Bose was one of the earliest microwave physicists. In 1902 he shifted his research interests to plant physiology and plant bio-physics. He innovated a number of high precision instruments for his researches. He is considered as the forerunner of modern biophysics. He won many honours including Fellowship of the Royal Society of London (FRS) in 1920.

Both of them were teachers per excellence and splendid experimentalists. Their lectures in the classroom were always accompanied by experimental demonstrations. They innovated simple experiments with easily available materials. They were also very good at public lectures on science, these lectures were often accompanied by practical demonstrations. Two such experimental demonstrations, one by Bose and another by Raman, are described here. \*Bose's experiment demonstrated the death of plant cells by heating. Raman demonstrated demagnetisation of permanent ferromagnets by heat. Demagnetisation may be considered as death of a magnet. Death of a living body and demagnetisation are both irreversible processes. That means they cannot regain life or magnetic property just by reversing the process by which (here, rise in temperature) death or demagnetisation was caused.

**\* The author learnt about Bose's experiment personally from N.S.Sen (1883-1972) who was a long time research assistant to Bose and about Raman's experimental demonstration from M.M.Ghosh (1906-1991) who was taught by Raman when the former was doing post-graduation.**

## Effect of Temperature

Significant changes in temperature bring about physical and chemical changes in a material body. Temperature is the indication of molecular motion or molecular and atomic disturbances within a substance. Living cells have specific structural organisation which in turn is a reflection of molecular configurations. Heating beyond a limit destroys that organisation causing death. Pasteurisation, which is the process of sterilisation by heat, has been possible because of this reason. Molecular configurations of most of the germ cells are damaged severely above a certain temperature. So the germ cells die.

Non-living matters also show interesting changes. Molecules or rather atomic configurations of crystal lattice in a magnet are organised in certain specific manner. Heating starts disturbing this lattice configuration, with rise in temperature a permanent magnet starts losing its magnetic property. As a specific high temperature, called Curie point or Curie temperature, magnetism is completely and abruptly lost. Curie temperature is specific for a specific type of magnetic material.

### Curie Point

Curie point or Curie temperature is the temperature at which ferromagnetic material loses its magnetism. Above Curie temperature, the material usually behaves as a paramagnetic material. The name is from Pierre Curie (1859-1906) who discovered this phenomenon in 1895. In that year he married Mary Curie (1867-1934). They together got the Nobel Prize in 1903 for their work on radio-activity. Curie Points of some of the well-known ferromagnetic materials are as follows.

<i>Ferromagnetic material</i>	<i>Curie point in °K</i>	<i>Curie point in °C</i>
Magnetite or magnetic oxide of iron	843	570
Iron (Fe) (Steel)	1043	770
Cobalt (Co)	1388	1115
Nickel (Ni)	631	358
Gadolinium (Gd)	289	16
Dysprosium (Dy)	85	-188

In each case of death or change of a stable property (such as magnetism) there is a sudden jerking end. Just before the end comes there is a severe, quick molecular change and sharp violent or erratic response. J.C. Bose called it the death spasm. The experiments described here can be shown by teachers as classroom demonstrations in school or in science exhibitions by students.

### **Bose's Demonstration**

Bose took a stem of some length from a live creeper plant like pumpkin. With a sharp razor blade or knife the stem was cut in the form of a spiral. This was then put in cold water (at room temperature) in a beaker of appropriate size and securely held. The water should not fill more than two-thirds of the beaker. The upper end of the stem thus prepared was fastened to string or thread of sufficient strength. The beaker was placed on a stand at a suitable place so that it could be heated by a soft flame. The string was vertically held from a hook in the ceiling of the room or by means of support. A small mirror was attached to the string at a suitable height above the beaker. Such mirrors are easily available as are used for decorating ladies handbags. The

arrangement was similar to the mirror arrangement of a reflecting string galvanometer. A sharp pencil of light was made to fall on the mirror from a strong source of light. The reflected light pencil was received by a screen. A wall of the room could also be used as a screen. A thermometer (which could read up to 100° C) was put in the beaker.

The demonstration room was made dark, so that the movement of the reflected light spot on the screen could be clearly visible. Only a small light showed the beaker and the thermometer. The water in the beaker was then heated gradually with a soft flame. As the temperature rose, the spot of light started moving in a slow pace. When the temperature was above 60°C the pace of movement increased. At temperature above 60°C the movement became violent, the light spot shot to other side and then stood still. With further rise in temperature the light spot did not move. It meant that the plant cells had died with a spasm. One could read the temperature at which the spasm started and when exactly the end came. It is the temperature at which pasteurisation is best performed (see box).

### **Pasteurisation**

Pasteurisation is a process which is used to prevent spoiling of liquids such as beverages or milk. The process can be affected in two different ways. In the first, the liquid is heated at about 60-65°C for 30 minutes. Otherwise it may be heated up to 75°C for only 15 seconds. In this way the living bacteria which cause spoiling are destroyed but the flavour, taste, etc., are retained; vitamins are also preserved.

The process got its name from the name of Louis Pasteur (1822-1895). Pasteur was a great French scientist and one of the proponents of germ theory of disease. During 1860's he was approached by the persons in brewery industry to solve the problem of spoiling of wines and beers. He found that the process of fermentation by which sugars and carbohydrates are transformed into alcohol are caused by certain bacteria. Alcohol (ethyl alcohol) is the main ingredient of wines and beers. If the bacterial activities were allowed to continue, there was over-fermentation and the beverage might become spoiled.

After many trials Pasteur was able to find the solution sterilisation by heating. The word pasteurise as a verb to mean the process was first used in 1881. The term pasteurisation was used for the first time on 21st October, 1886 in the newspaper *Times* of London.

When Pasteur did his experiments on sterilisation of liquids (first with brews or wines), he did not think of the death of plant cells. But most of the germs which are bacteria are nothing but microbial plants. When J.C. Bose innovated this experiment, he did not link the death temperature with temperature of pasteurisation. But well, the connection is apparent.

If the flame was removed and the temperature allowed to go down, there would not be any movement of the light spot in other direction. The process is irreversible. One could be more sure by taking sectional samples from the stem before and after the experiment and comparing them under a suitable microscope.

## Raman's Demonstration

### C.V. Raman

C. V. Raman was born in Madras on 7 November, 1888. He was a brilliant student all through. He passed Matriculation examination at the age of eleven and half years. He passed M.Sc. examination in Physics from the Madras University at the young age of 18 standing first class first in the order of merit. He published research papers in famous international journals even when he was a student.

He then appeared in all-India examination for Financial Service of the Government of India. He stood first in that examination also. He was posted in Calcutta as Assistant Accountant General. He was in this service for ten years. But he continued doing research in physics in his spare time. This did not go unnoticed. In 1916, he was directly appointed as Professor in the University of Calcutta. He remained there till 1933 when he moved to the Indian Institute of Science, Bangalore. In 1947 he established Raman Research Institute in Bangalore and remained there as Director till his death on 21 November, 1970.

Raman along with his student K.S. Krishnan started working on scattering of light by liquids in 1925. In 1928 they discovered Raman's effect. In 1930 Raman was awarded the Nobel Prize. Till now he is the only Indian to have received the Nobel Prize in Science working in India. He was elected F.R.S. in 1924.



For demagnetisation experiment of Raman, a strong permanent bar magnet was taken. Its length should be between 20 and 50 cms. The magnet was tightly held in the middle by a support. The two ends were kept free. At the one end there was arrangement for strong heating. Near the other end a soft-iron ball was suspended by a string. The string might be a metallic wire (but not of steel which might have some magnetism) or a good cotton thread. Now-a-days threads of synthetic materials such as nylon or PVC are available. But they should be avoided. Such a precaution is necessary because a string of synthetic material may be affected by heat.

The weight of the soft iron ball should be appropriate. The ball should have a hole through it like the beads of a necklace or it should have a hook for fastening the string. In Raman's days such balls were not readily available and were to be fabricated. But one may now buy one or get one from a junk store even.

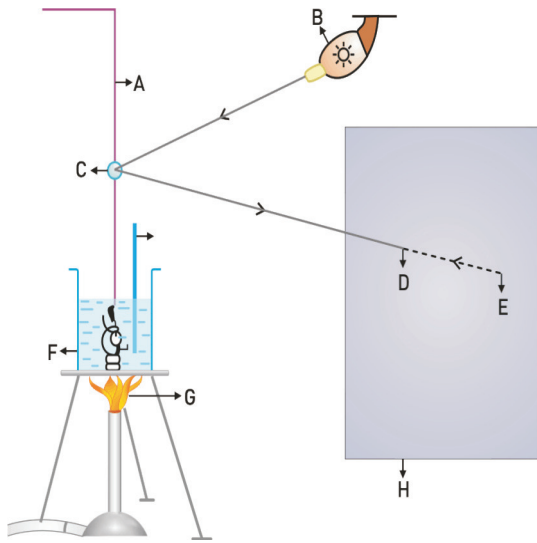
Even the ball was suspended near one end of the magnet (opposite the end where heating lamp or burner was placed) in an appropriate position, the ball was attracted to the magnet and stuck to it.

The other end was then heated by a strong flame. After a while the iron ball started to shift away slowly from the magnet. When the Curie point was reached the ball flung away with a jerk and started swaying like a pendulum. After some time it was vertically hung having the only attraction of gravity. Then the flame was put off. The magnet was set to cool. Even after cooling there was no return of magnetic attraction. Demagnetisation is an irreversible process.

One point is important here. One cannot use a simple thermometer to note or measure the Curie point as the Curie points of all the available ferro-magnetic materials are several hundred degree celsius. Raman could do it by some sophisticated thermometer such as a radiometer or a thermocouple thermometer of suitable range. If a thermometer which can read up to 1000°C be available, Curie temperatures can be shown.

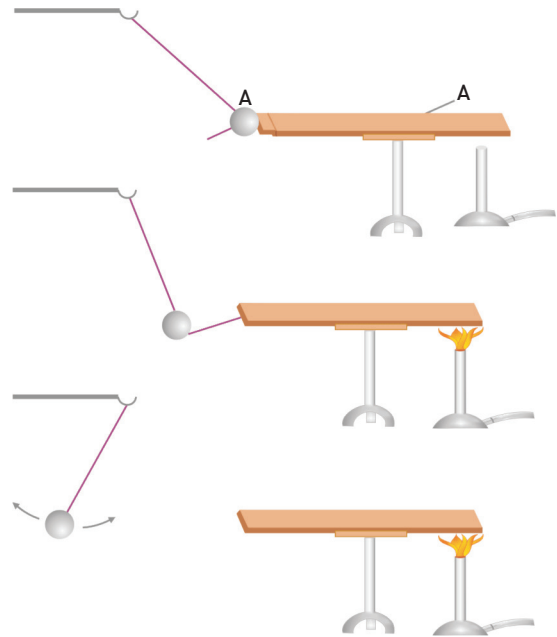
Any teacher wanting to use this classroom demonstration, should remember another point. Every time this experiment is to be performed, a permanent magnet is to be sacrificed. Or, if one likes to show different Curie points for different materials, one should be prepared to sacrifice several magnets. These differences in Curie points can be shown directly by using a suitable thermometer. However, for want of a thermometer an imprecise indirect method may be used. By keeping the heating flame in the same state and noting down the time taken for demagnetisation (the point of jerked swaying) the differences can be illustrated. It is advisable that one should make some arrangement for magnetizing the bar each time after the experiment so that the same bar magnet can be used again and again.

The experiments described here are comparatively easy. One should however remember that for every experimental set-up, there are a number of problems and hazards, minor and major which are to be faced and overcome. Before the first successful result, there may be many failures.



J.C. Bose's Experimental Demonstration on Death Spasm of Plant Cells

- |                 |                             |                |
|-----------------|-----------------------------|----------------|
| A: Thread       | D: $\geq 60^\circ$          | G: Soft flame  |
| B: Light source | E: Start                    | H: Screen Wall |
| C: Mirror       | F: Strongly held plant stem |                |



C.V. Raman's Experimental Demonstration on Death of Magnet (demagnetisation) by heating to Curie point  
 A: Iron ball  
 B: Permanent magnet

# WHY ANIMAL DISSECTION IN THE SCHOOL?

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If there is one area of our interest where Newton's third law of motion does not quite apply, it is most certainly to education. For every educational advance, there is an opposite but unequal and vehement reaction. This is almost a global phenomenon. In the US, for example, if one attempts to teach evolution, one is harassed by anti-evolutionists. Over a hundred years after Wilberforce and Huxley exhausted all their arguments, there are pockets of anti-evolution sentiment. While teaching the biology of sex, one is attacked by anti-sex educationists, despite climbing rates of AIDS. There are those who wish to prohibit schools from discussing matters that pertain to sex.

One of the more recent trends is resentment of the use of organisms in the laboratory. In some states in the US there are laws that prohibit the use of animals in the classroom for any purpose whatsoever.

As well as in the US, some people in India are asking for restrictive legislation on this not because they care to understand the processes of education or the purpose these processes are expected to serve. Such groups are headed by vocal minorities wielding political pressures. Tenable and untenable arguments are hurled at

each other by pro and anti-dissectionists. Some of these arguments – from both sides – are either trivial or at best rite; no comments on those are called for. What is necessary is an objective analysis of the school biology curriculum, the desired outcome in terms of learning experience, practices in schools insofar as dissection of animals is concerned and examination of possible alternatives to dissection that can be adopted for our schools.

The value of dissection can only be judged in the fuller context of experience, feeling and morality.

## The Case against Dissection

Many of the criticisms leveled at the use of laboratory animals are not criticisms of facts but rather of opinions. Often they are hodgepodge of desperate views. We can try to bring some kind of coherence in them thus:

The act of dissection brutalises pupils. What they do to organisms in a dissection class is a reflection of the way they will treat fellow humans.

Dissection is a tradition-bound activity that survives on the ground that it has always been a part of the syllabus.

A large number of students are numbered by revulsion at the dissection table. In such cases, children should have the option of learning anatomy and morphology with the help of charts, models, computer simulations and other available aids.

Many of these students give up biology as an elective subject at the Senior Secondary stage driven by their traumatic experience of dissecting animals.

A huge number of amphibians and rodents are destroyed every year in Indian schools as children dissect these animals. This disturbs the ecological balance and threatens some animals with extinction.

In many countries, notably in the UK and the USA, many schools have done away with dissection.

The practice of dissection, therefore, should be abolished from school biology.

Emotions often run high while people debate on these. We shall look at them only dispassionately.

First, the contention or inference that what people do to organisms during dissection is a reflection of the way they will treat their fellow humans is based on wild assumptions.

Secondly, there is no single curricular activity that makes all pupils happy or unhappy. Emotional disturbance may arise as a result of shock on the sight of dissected animals. Such disturbance may arise from the use of film showing exposed heart or blood. In my ten years as a biology teacher, I didn't come across a single student who gave up biology due to emotional disturbance. I know many a student who feel excited about the

dissection class and make it a point that they don't miss it. Most students feel like surgeons when operating on anaesthetised rats.

Thirdly, these who choose biology as an elective subject at the Senior Secondary stage (and dissection is a prescribed activity only for them, not for any earlier stage of schooling), are no longer children but young adults. They opt for biology willingly with a career prospect in mind. If some of them later find themselves too sensitive to dissection, they can amend their choice of subject. In any case, it is not sufficient to argue the case against dissection on grounds that 'children are Squeamish'.

Fourthly, a strong ecological point is often made against dissection. The species *Rana tigrina* is threatened with extinction allegedly because of its large scale use at the dissection table. Common toads are no better off. The fact of the matter is that amphibians have long been excluded as animals for dissection. If *Rana* becomes extinct before long, it would be because too many people look for its delicate legs at the dinner table. Export of these legs is lucrative business. Rats, which are known pests that are destroyed regularly at a much large scale to prevent loss of foodgrains, are the animals that are dissected in the biology classroom. The rate at which rats breed outpace their rate of destruction through dissection in schools. The extent of ecological disturbance caused by dissection of two or three specimens by a student in two years at the Senior Secondary School is far from established. The number of animals that would be saved by abolishing the practice of dissection from the school stage would be insignificant.

Finally, when one is faced with the charge that laboratory experimentation diminishes pupils'

kindness towards animals, one has the option of dismissing such a charge as simply a visceral feeling, *for there are no measures of degree of kindness*. Emotional and moral issues continue to be there no matter whether animals are sacrificed at the school level or in the college.

I have heard people saying that if aeroplane pilots and cardiac surgeons can be trained on simulators, why can't students of biology learn anatomy with computer simulations. Strong argument! And whatever its merit, it has been put to practice in some countries albeit at a limited scale. Curriculum developers may try to work out the input required to (i) create what is widely known as virtual reality that makes you feel as though you were dissecting an animal, (ii) produce multi-media packages that simulate dissection, (iii) provide schools with the hardware that handles CD-ROMs and, of course, (iv) procure necessary software.

## **The Case for Dissection**

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The argument in favour of dissection usually runs like this:

The skill of dissection is important for biological investigations at all levels. Information and skills obtained through dissection are a necessary aspect of the training of those who aspire to be biologists, nurses, doctors and the like.

There are people who acknowledge the benefits derived from studies involving dissection. They see beauty and fascination in the bodies of organisms and have a first-hand understanding of the working of the bodies of living things.

Alternatives to dissection – charts, model, photographs or computer software – can be used to supplement dissection. But examination of the actual object results in better learning than through the use of representative materials.

This train of argument is not devoid of interest points. First, the skill of dissection is thought to be necessary for future biologists, doctors and nurses. That is a strong suggestion that dissection is preparatory to something that would take place some time in future; it has no intrinsic value in the context of school biology *per se*. If so, it is not clear why two or three sessions of dissection that pupils go through must be had in schools and not in the first year in degree colleges or in medical colleges or nursing schools. The rationale for dissection must be found within the framework of the school curriculum; if it is not there, dissection should be abolished from schools.

Secondly, more surgeons than one think that the skill that one acquires in the school dissecting a couple of rats is of little value to a medical student who has to work on the human body. The experience of dissecting rats helps one dissect more rats, more efficiently in some cases.

Finally, let us accept that although in most schools dissection is done, as it should be, on anaesthetised animals, schools laboratories have very poor hygienic conditions. Arrangements in schools for disposal of used animals are pathetic, to say the least.

## **What Then!**

Animal dissection in schools has been dragged into much controversy. The solution lies in an

objective response to the singular question, and its natural extension: Is dissection an essential activity for learning biology at the Senior Secondary level? If so, why?

The primary source where we should search for an answer is the biology curriculum which prescribes dissection of rats at the Senior Secondary level.

From Primary classes through the terminal years of schooling, study of the human body – its internal structures and functions of its various organs – is a constant feature of school biology. A substantial portion of the biology course for classes eleven and twelve is description of mammalian anatomy with the example of various systems of man.

The internal anatomy of any mammal, even that of a rat – black or white – it is a useful model that helps understand the human anatomy.

Dissection, like any other practical activity, offers the opportunity to combine cognitive knowledge

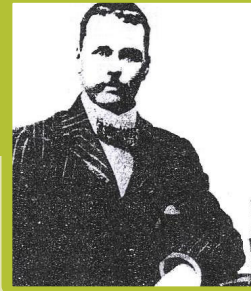
and psychomotor skills. It reinforces both; one cannot dissect without the knowledge of anatomy and the knowledge of anatomy is grossly incomplete if it is not acquired through dissection. Besides, dissection is as much a means of biological enquiry as it is an exercise to acquire manipulative and investigatory skills. It is the only way to investigate the internal organs and the spatial and physiological relationships between various structures and their functions. Understanding of these is one of the desired outcomes of school biology. This makes a strong case for animal dissection as an essential component of biology curriculum at the Senior Secondary stage.

It is not much of a child who does not dismember toys, dismantle beyond repair household appliances – much to the annoyance of elders – and ‘dissects’ whatever other object it can lay its hands on. This is instinctive behaviour of the child to explore the unknown. Animal dissection is but a disciplined way to explore the anatomy of animals. Don’t stop it.

# FIGHT AGAINST MALARIA AND RONALD ROSS

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Malaria has been one of the biggest killer diseases in the history of humanity. Not cholera or plague, nor to speak of AIDS. It is estimated that during the Second World War, more American soldiers in the far east died of malaria than that killed by the human enemy. It still remains the number one public health problem in many countries. More than one million people die in Africa. In India alone 20 to 30 million people suffer from malaria every year. In spite of continuous advances in malariology, and advances in public health services, it is still causing havoc taking heavy toll of life and inflicting severe damage to the health of the people. Malaria is one of the most important causes of economic misfortune, engendering poverty, diminishing the quality of food supply, lowering the physical and intellectual standard of the nation. It also harms economic progress in every way.

Human fight against malaria is a unique story. This is a long story spreading over two thousand years with many ups and downs. It is an example of how finding solutions to a long standing problem of such a magnitude requires combined efforts of every branch of science— medicine, biology and chemistry as well as organised health

service, social action groups and above all strong political will. Whenever a favourable combination could be achieved, the control of the disease seemed at sight. And in fact, it had been eradicated from a large part of the globe. Slackness in any one respect or more has caused reversal of greater magnitude. In this article, however, we shall restrict ourselves mainly to the bioscientific aspects of the story depicting the nature of science and history of ideas. It might also illustrate how the knowledge of one period becomes a myth later in history and how science progresses gradually.

Till less than a century ago occurrence of malaria was spread over all continents. In the old world it has been a menace in the south and southeast Asia, Japan, northern Australia, southern Russia, Great Britain, continental Europe and almost all inhabitants areas of Africa. In the western hemisphere malaria was preponderant from central South America to the southern fringes of Canada. Today whole of North America, Europe and a large part of South America are almost free of malaria. All ancient civilisations namely that of China, Egypt, Greece, India, Iraq and Italy were plagued by malaria. It is said that Alexander the

Great of Macedonia died of the disease. Some believe that decline of Greek and Roman civilisations were partly caused by malaria.

## Symptoms of Malaria

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Usually malaria is characterised by a high fever with feelings of cold, headache, muscle-ache, dry mouth and rough skin. After a few hours the patient feels warm and has nausea, followed by sweating and remission of fever. If untreated this sequence recurs every 48 hour (72-96 hours in some cases) for several weeks. Thereafter the patient may be relieved for a few months or even a year. He often gets similar attacks repeatedly resulting in anaemia, enlargement of spleen, physical emaciation and lastly death. In one type of malaria, one or a few spells of high fever may lead to rapid deterioration and sudden death if suitable treatment is not given in time.

## A Long Search for the Cause

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As mentioned earlier, all the ancient civilizations were serious victims of malaria, Even two thousand years ago some of the physicians had preliminary ideas about the disease. They could recognise malaria by its symptoms and called it 'intermittent fever'. Some of them could even distinguish between different types of malaria also. It was widely noted that the disease preponderates in marshy areas, near swamps and was more frequent among people who slept outdoors. They thought that it was caused by breathing foul air poisoned by the stagnant water. The disease also acquired its name from the same belief (Italian: mal-bad, aria-air). It may seem to be

silly today but even this belief helped to control the disease to some extent.

Since the disease was associated with stagnant water, the Romans tried to control the disease by flushing swamps and marshes. Roman officers posted in certain areas of the empire observed that the places having large population of buffaloes who frequently visited swamps were comparatively free from malaria. They imported buffaloes from Egypt to southern Italy where the disease was rampant. This measure also gave some respite. Can you imagine why?

After the decline of the Romans, the West entered the dark age. No significant progress in respect of malaria could be made in the next thousand years or more, till the late renaissance period. However, it has recently come to light that in the sixth century a Chinese philosopher accidentally discovered a 'warm wood' tree (Artemisia enua, Chinese name: Kunghow tsud) the bark of which was effective for the treatment and prevention of malaria.

After the advent of renaissance a new awakening swept through Europe. Old ideas and authorities were begun to be challenged. New ideas based on explorations, experiments and observation poured in. Ideas about land and oceans expanded. The new world (western hemisphere) was discovered. The Europeans started getting hitherto unknown samples of plants and animals as well as experiences and ideas extant in distant lands.

In the seventeenth century a large variety of substances derived from plants, animals and minerals were tried to cure different diseases



including malaria. Most of them were of no value; some of them were even harmful. Among those some were products sent from abroad. One of these products was the bark of a Peruvian tree (native name: quina quina) which the local people used as a medicine for fever. This was thought to be a good benign cure of malaria in Europe and became very popular. The demand for the bark of the tree rose so high that soon it became difficult to arrange for its transport. The supply source also tended to become exhausted. Some dishonest merchant began to substitute it by a similar looking bark of another tree. Strangely, this attempt of gross adulteration became an unexpected benefit. It was found out that quina quina was not as effective as the new adulterant was. The new tree yielding the effective medicine of malaria was named Cinchona after the name of the wife of the then Portuguese governor. Later the active fraction extracted from Cinchona bark called quinine remained the only potent cure till mid-twentieth century. Is it not strange that a drug that served humankind for three centuries was discovered accidentally that too from an adulterant?

## The Parasite Discovered

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After a satisfactory treatment was found, physicians tried to verify the cause of malaria. Some of them volunteered to drink water of the swamps that were said to be the cause of fouled air. Some deliberately breathed the air around the marshes. No one got malaria. The age old ideas began to change. Several speculations were floated. Some scientists dissected and examined the body parts of the dead patients; others

examined the blood of suffering patients. A few held the newly discovered bacteria as the causative agent. But no satisfactory solution could be found for a long time.

Malarial parasites were apparently first seen by Meckel in 1847. Several others also reported some stages in the blood of human being. Significance of their discovery was not recognised until Laveran's somewhat explicit studies were published in 1880 who was able to see them in the blood corpuscles of malarial patients. Subsequently the scientists reported different stages of the parasite in and out of the RBC. By then it was known that malaria is also common in many birds and apes. In 1885 Marchiava and Celli produced cases of malaria by inoculating human volunteers with blood containing the parasites. Gradually it was accepted that malaria is caused by a protozoan parasite belonging to the genus *Plasmodium*. It was also found that there are four species of the genus namely, (i) *P. vivax*, (ii) *P. falciparum*, (iii) *P. Malariae* and (iv) *P. ovale* which are responsible for different kinds of malaria.

*P. vivax* causes benign, tertian (fever every alternate day) malaria, resulting in slow degeneration of the patient engendered by destruction of the RBC. The benign nature of this type of malaria often tempts patients to neglect its treatment. This altitude has aggravated its effect on the population. *P. falciparum* is responsible for malignant, tertian malaria (also called cerebral malaria). It is the most dangerous form of malaria. It affects the brain leading to fast deterioration of the patient and sudden death if proper treatment is not given in time. *P. malariae* causes benign, quadrant (fever every 72-96 hours) malaria which

is not so much dangerous. *P. ovale* is responsible for tertian malaria which is even milder.

The relative incidence of these parasites and hence the occurrence of different malarias varies in different parts of world. Some differences are also observed in the same area from year to year. *P. vivax* is of widest distribution (about 65%-69%) : *P. falciparum*, the killer malaria comes second (25%-30%) : *P. malariae* has a restricted distribution (1%-3%) and *P. ovale* is a rare parasite in man.

### Carrier Identified

Once it was known that malarial parasites are causative agent of the disease and a person gets malaria if he receives blood of another person containing the parasite, scientists wondered who injects the parasites in the normal cases. Since malaria is associated with stagnant water which was the home of many insects including mosquitoes, the latter became the main suspects. As early as in 1717, Lancisi stated that marshes cause malaria though the transformation of minute worms into mosquitoes which infused a poisoned liquid into the wounds they inflict. What did he observe in the marshes? Must be mosquito larvae, what else? In 1883 Kreig and King produced circumstantial evidence to pinpoint the mosquito as an agent of transmission of malaria. Laveran, Manson, Pfeiffer and many others were of the same opinion. But experimental proof was eluding them. It was Ronald Ross who first took up experimental investigation into the role of mosquitoes.

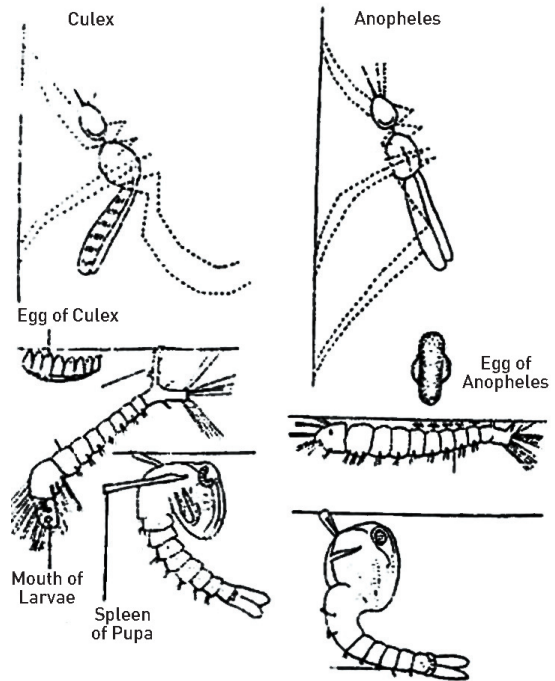


Fig. 1. Life history of the mosquito (Anopheles and Culex). Note the differences in the sitting postures of their adults; shape of egg and position of larva.

As the first step Ross experimentally verified that it is the Anopheles mosquito and not the other species that suck in the material parasites from infected patients along with his blood. He also showed that these parasites multiply in the stomach wall of the mosquito establishing thereby that the Anopheles mosquito was the natural host of these parasites (1897). It was a very significant contribution. Then he went on to demonstrate that malarial parasites are injected into another victim during a mosquito bite. But without human volunteers he had to work with

bird malaria (*Proteosoma sp*) in sparrows. He discovered *sporozoite* stage of malaria in the salivary glands of the mosquito (1898). So, the human mosquito-malaria enigma was solved.

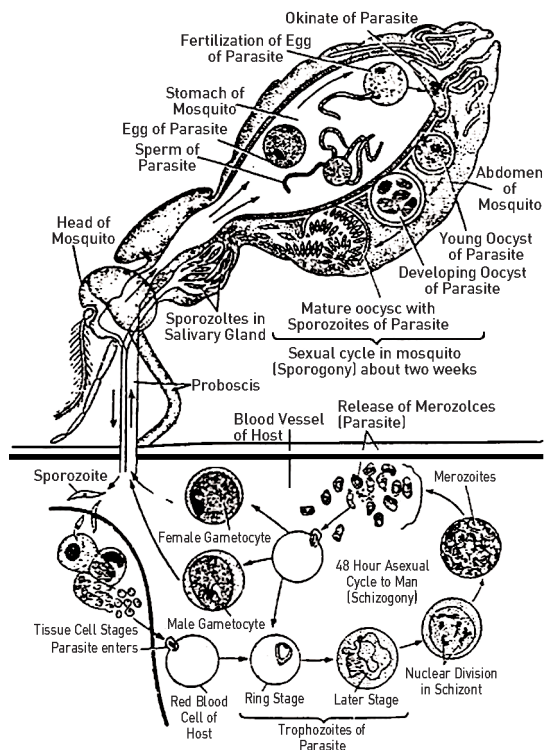


Fig. 2 Life history of malarial parasite *Plasmodium*, showing different stages in mosquito and human body.

Immediately after, Grassi (1898-99) found similar cycles in *P. falciparum*, *P. vivax* and *P. malariae*. He also unequivocally demonstrated that mosquitoes act as vectors and transfer malaria in man. Ross's work, therefore, cleared several mysteries of the past, opened the door for many future discoveries and paved the way for launching antimalarial campaigns on a global scale.

### Ronald Ross

Sir Ronald Ross was awarded the Nobel Prize in 1902 'for his work on malaria by which he has shown how it enters the organism and thereby laid the foundation for successful research on this disease and how to combat it'. He was the second Nobel Laureate in medicine and physiology since its inception.

He was born at Almora in the Kumaon hills of Uttar Pradesh on 13 May, 1857. He came of a three generation Anglo-Indian family and was the eldest son of a general in the Indian Army. He had his medical education in England. After obtaining the MRCP Diploma in 1879, he worked as a surgeon of a ship for some time and then entered the Madras Medical Service. During his home leave in 1888, he studied bacteriology and got DPH Diploma. He also got some familiarity with mosquitoes. He returned to India in 1892 and began to take special interest in malarial parasites. He took the opportunity of observing and studying the parasites under the guidance of Patric Manson during his second leave in 1884. Coming back to India next year he devoted himself to experimental investigations of the mode of transmission of malaria. He remained in touch with Manson who always encouraged him. But his research was constantly being hampered by frequent transfers at its crucial stages. In spite of the impediments he continued resolutely and got the breakthrough in 1897 and 1898. Thereafter he was sent to Assam to investigate the large scale occurrence of black fever (kala azar). The same year he took retirement from the Indian Medial Service and migrated to England. He joined the Liverpool School as a lecture where he became a Professor

in 1902. In 1912 he joined the King's College Hospital, London as a physician for tropical diseases. During the First World War (1914-18) he worked as consultant in various organizations to advise on antimalarial campaigns.

Apart from scientific papers and his Memoirs, he wrote several books on poems and romances. Ross was honoured with investiture of Knight Commander of the Order of the Bath in 1911 and in 1918 he became knight Commander of the order of Saint Michael and Saint George. Later, in 1926 the Ross Institute and Hospital for Tropical Diseases was established in his honour at Putney. He breathed his last at Putney in 1932.

Can you now understand why draining of marshes and introduction of buffaloes had helped Romans in reducing malarial cases locally. Obviously these steps caused disturbance to the breeding grounds of mosquitoes.

## Eluding Control

Once the vicious cycle of man-mosquito-malaria was known it became clear the eradication of malaria can be attempted in two ways: (i) curing malaria patients by effective drugs thereby reducing the source of the parasite, and (ii) destroying the mosquitoes mainly by controlling their breeding and development so that the transmission of malaria was interrupted.

By mid-twentieth century preparation for malaria eradication was complete. Effective drugs (quinine, chloroquine, antibiotics) for cure of malaria became easily available. At the same time powerful insecticides (DDT, BHC etc.) and

mosquito repellents for suppressing mosquito menace were also on the racks. Adoption of the two pronged attack went very well by early sixties of the twentieth century. The disease was totally suppressed in several countries and quite tamed in many others including India. The death per year came down from three million in 1946 to two million in 1961. The total number of incidence also sharply declined. It was hoped that the disease would totally be controlled within two decades. However, only those countries whether developed or developing, succeeded in their efforts which never loosened their grip on the eradication campaign. A sense of complacency crept in at this crucial junction of the campaign both at the global efforts as also at the country level campaigning. The attention was diverted to the wars in the Southeast Asia, flow of money tapered off and the operation plans had to be down sized. Medical attention both for research and training shifted to more challenging areas, malaria eradication programmes of the Public Health Services became tardy. This was followed by injudicious use of drugs often faulty treatment schedule as well as indiscriminate use of insecticides. The consequence was disastrous. New strains of drugs resistant parasites and insecticide resistant malarial mosquitoes emerged to make the task of cure and control more difficult. The worst was the development of drug resistance types of malignant of cerebral malaria (*P.falciparum*) and their rapid invasion in different parts of the world including India.

However, experts say that the war against malaria is not lost as yet. The man-malaria fight can still be tilted in favour of human if we renew the campaign with all the vigour and resources at our command correcting our past mistakes. Even

with arsenal of existing drugs and the available insecticides the campaign can achieve success. In this centenary year of Ross's great discovery and fiftieth year of India's independence. We could make us proud by taking a sincere pledge to eradicate the curse of malaria from our country.

### **Description of the Prize Winning Work\***

"Towards the middle of August (1897) I had exhaustively searched numerous grey mosquitoes and a few brindled mosquitoes. (Unable to obtain literature on mosquitoes, Ross made a working classification of his own and invented simple names. His grey mosquitoes belonged to the genus *Culex*, his brindled mosquitoes to the genus *Stegomyia*.) The results were absolutely negative; the insects contained nothing whatever....

"I had remembered the small dappled winged mosquitoes (genus *Anopheles*), but as I could not succeed either in finding their larvae or in inducing the adult insects to bite patients, I could make no experiments with them. On the 15th August, however, one of my assistants brought me a bottle of larvae, many of which hatched out next day. Among them I found several dappled-winged mosquitoes, evidently of the same genus as those found about the barracks, but much larger and stronger. Delighted with this capture I fed them (and they proved to be very voracious) on a case with crescents in the blood. Expecting to find more in the breeding bottle and wishing to watch the escape of the motile filaments in this new variety, I dissected four of them for this purpose immediately after feeding. This proved to be most unfortunate, as there were no more

of these insects in the bottle, and the results as regards the motile filaments were negative. I had, however, four of the gorged dappled-winged mosquitoes left; but by bad luck two of the dissections were very imperfect and I found nothing. On the 20th August I had two remaining insects both living. Both had been fed on the 16th instant. I had much work to do with other mosquitoes, and was not able to attend to these until late in the afternoon when my sight had become very fatigued. The seventh dappled-winged mosquito was then successfully dissected. Every cell was searched, and to my intense disappointment nothing whatever was found, until I came to the insect's stomach. There, however, just as I was about to abandon the examination, I saw a very delicate circular cell apparently lying among the ordinary cells of the organ, and scarcely distinguishable from them. Almost instinctively I felt that there was something new. On looking further, another and another similar object presented itself, I now focused the lens carefully on one of these, and found that it contained a few minute granules of some black substance exactly like the pigment of the parasite of malaria. I counted altogether twelve of these cells in the insects, but so tired with work and had been so often disappointed before that I did not at the moment recognise the value of the observation. After mounting the preparation I went home and slept for nearly an hour. On waking, my first thought was that the problem was solved; and so it was.

"Next morning... the eighth and last dappled-winged mosquito... was killed and dissected with much anxiety. Similar bodies were present in it...The objects lay, not in the stomach cavity of

the insects, but in the thickness of the stomach wall...

“These two observations solved the malaria problem. They did not complete the story, certainly; but they furnished the clue. At a

stroke they gave both of the unknown quantities— the kind of mosquito implicated and the position and appearance of the parasites within it”.

**\*From Ronald Ross. “Research on Malaria” has  
prix Nobel en 1902**

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# THE FASCINATING JOURNEY OF CHROMATOGRAPHY

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Chromatography has numerous applications in biological and chemical fields. It is widely used in biochemical research for the separation and identification of chemical compounds of biological origin. Chromatography is employed to analyse complex mixtures of hydrocarbons. As a separation method, chromatography has a number of advantages over other techniques such as crystallization, solvent extraction and distillation. It is capable of separating all the components of a multi-component chemical mixture without requiring an extensive fore knowledge of the identity, number or relative amounts of the substances present. It is versatile in that it can deal with molecular species ranging in size from viruses composed of millions of atoms to the smallest of all molecules – hydrogen – which contains only two atoms. Furthermore, it can be used even with large or small amounts of material. Some forms of chromatography can detect substances present at the pictogram ( $10^{-12}$  gram) level, making this method a superb trace analytical technique extensively. It is used in the detection of chlorinated pesticides in biological materials and the environment, in forensic science, and in the detection of both therapeutic and abused drugs. Its resolving power is unequalled among separation methods.

Chromatography is defined as a technique for separating the components or solutes of a mixture on the basis of the relative amounts of each solute distributed between a moving fluid stream, called the mobile phase and a contiguous stationary phase. The mobile phase may be either a liquid or a gas, while the stationary phase may be either a solid or a liquid or a gas, while the stationary phase may be either a solid or a liquid. The kinetic molecular motion continuously exchanges solute molecules between the two phases. If, for a particular solute, the distribution favours the moving fluid, the molecules will spend most of their time migrating with the stream and will be transported away from other species whose molecules are retained longer by the stationary phase. For a given species, the ratio of the time spent in the moving and stationary regions is equal to the ratio of its concentrations in these regions, known as the partition coefficient. A mixture of solutes is introduced into the system in a confined region or narrow zone (the origin), whereupon the different species are transported at different rates in the direction of fluid flow. The driving force for solute migration is the moving fluid, and the resistive force is the solute affinity for the stationary phase; the combination of these forces, on manipulation by

the analyst, produces the separation of various components.

The first purely pragmatic application of chromatography was with dyes. Various dye mixtures were tested by dipping strings or pieces of cloth or filter paper into a dye vat. The dye solution migrated up the inserted material by capillary action, and the dye components produced bands of different colours. In the 19th century, several German chemists carried out several experiments to explore the application of chromatography. They observed, for example, the development of concentric, coloured rings by dropping solutions of inorganic compounds onto the center of a piece of filter paper. A treatise was published in 1861 describing the method and giving it the name "capillary analysis".

The discovery of chromatography is generally attributed to the Russian Botanist Mikhail S. Tsvet, because he recognised the physicochemical basis of separation of plant pigments, particularly the carotenoids and the chlorophylls. Tsvet's book, published in 1910, described a technique that is used today in essentially the same form. He packed a vertical glass column with an absorptive material, such as alumina, silica or powdered sugar, added a solution of the plant pigments to the top of the column, and washed the pigments through the column with an organic solvent.

The pigments separated into a series of discrete coloured bands on the column, divided by regions entirely free of pigments. Because Tsvet worked with coloured substances, he called the method chromatography (from Greek word meaning colour writing). Tsvet's development of chromatographic procedures was generally unknown to chemists in the Western world

because he published either in German botanical journals or in Russian works. In 1931, chromatography emerged from its relative obscurity when the German chemist Richard Kuhn and his student, the French chemist Edgar Lederer, reported the use of this method in the resolution of a number of biologically important materials. In 1941 two British chemists, Archer J.P. Martin and Richard L.M. Synge, began a study of the amino acid composition of wool.

Their initial efforts, in which they used a technique called liquid-liquid countercurrent distribution, failed to give them adequate separation. Therefore, they conceived of an alternative method in which one liquid was firmly bound to a finely granulated solid packed in a glass tube and a second liquid, immiscible with the first, was percolated through it. Silica gel served as the granular solid. Martin and Synge pictured silica gel as composed of water tightly bonded to the crystals of silica. The mobile phase was Chloroform. Their work with this technique was remarkably successful. Although their method was mechanically identical with Tsvet's approach, it was innovative as it involved the concept of a stationary liquid (water) supported on an inert solid (silica), with the result that the solute molecules partitioned between the stationary liquid and a separate mobile liquid phase (chloroform).

The technique used by Martin and Synge came to be called partitioned chromatography. At that time, they suggested that the moving phase could well be a gas. It is a historical oddity that this idea was overlooked for nearly a decade, possible because of the war, until Martin in collaboration with British chemist Anthony T. James initiated



studies of gas-liquid partition chromatography. In 1952, Martin and Synge were awarded the Nobel Prize for their work, perhaps not so much for the newness of the technique but for a model that suggested other systems, a mathematical theory, and applicability to amino acids and peptide separations with far reaching impact on biochemical studies.

The initial partition-chromatography system presented difficulties because of lack of reproducibility in the properties of the silica gel and lack of uniformity in the packing of columns. Partly for this reason, Martin and his co-workers worked out a new procedure in which the stationary medium was a sheet of filter paper. The paper was thought of as water bonded to cellulose, providing another partition method. The technique gave the desired reproducibility, and from the beginning of 1940s, paper chromatography found wide application in the analysis of biologically important compounds, such as amino acids, steroids, carbohydrates and bile pigments. In this field, to a large extent it replaced the column technique initiated by Tsvet.

Motivated probably by the same drawbacks to column chromatography, two soviet pharmacists, Nikolay A. Izmaylov and Maria S. Shrayber, distributed the support material as a thin film on a glass plate. The plate and support material could then be manipulated in a fashion similar to that of paper chromatography. The results of the Soviet studies were reported in 1938, but the potential of the method was not widely realised until 1956, when the German chemist Egon Stahl began intensive research on its application. This system became known as Thin Layer Chromatography (TLC).

Yet another chromatographic technique, gas chromatography, was first carried out in Austria in 1944 by the chemist Erika Cremer, who used a solid stationary phase. The first extensive exploitation of the method was made by Martin and James in 1952, when they reported the elution gas chromatography of organic acids and amines. In this work, small particles of support material were coated with a non-volatile liquid and packed into a heated glass tube. Mixtures injected into the inlet of the tube and driven through by compressed gas appeared in well separated zones. This development was immediately recognised by petroleum chemists as a simple and rapid method of analysis of the complex hydrocarbon mixtures encountered in petroleum products. British Petroleum Co. and Shell Oil Co. immediately began basic research in their own laboratories. Various instrument manufacturing companies envisaging an extensive market, also made major contributions.

In 1957, while doing a theoretical study of gas chromatographic columns, Marcel J.E. Golay, as a consultant for the Perkin-Elmer Corporation, concluded that a very long column (90 to 180 metres or 300 to 600 feet) of narrow-diameter tubing (internal diameter of 0.25 millimetres) with its wall coated with a thin film of liquid would yield superior separations. Fortunately, at about the same time, detectors with extremely low limits of detection, which could sense the small sample sizes required by these new columns became available. These capillaries, or Golay columns, now called open tubular columns and characterised by their open design and an internal diameter of less than one millimetre, had an explosive impact on chromatographic methodology. It is now possible

to separate hundreds of components of a mixture in a single chromatographic experiment.

Molecular sieves are porous substances that trap a mobile-phase gas. Large molecules cannot enter the pores. Therefore they flow unimpeded through the system. Small molecules are interrupted in their migration as they meander in and out of the pores by diffusion. Molecules of intermediate sizes show different rates of migration, depending on their size. In 1959 Per Flodin and Jerker Porath in Sweden developed cellulose polymeric materials that acted as molecular sieves for substances dispersed in liquids. This extended the molecular weight range of chromatography to polypeptides, proteins and high molecular weight polymers. The generic term for such separations is Size-Exclusion Chromatography (SEC).

In 1964, an American chemist, J. Calvin Giddings, referring to a theory largely worked out for gas chromatography, summarised the necessary conditions that would give liquid chromatography the resolving power achievable in gas chromatography, that is, very small particles with a thin film of stationary phase in small-diameter columns. The development of the technique now termed High-Performance Liquid Chromatography (HPLC) depended on (i) the development of pumps that would deliver a steady stream of liquid at high pressure to the column to force the liquid through the narrow interstitial channels of the packed columns at reasonable rates, and (ii) detectors that would sense the small sample sizes mandated. At first, only adsorptive solids were used as the stationary phase, because liquid coatings were swept away by the mobile phase.

Previously gas chromatography had employed chemical bonding of an organic stationary phase to solids to reduce adsorptive activity; Istvan Halasz of Germany exploited these reactions to cause a separation based on liquid solution effects in the bonded molecular layers. These and similar reactions were employed to give firmly attached molecules that acted as a thin film of solvent in liquid systems. These bonded phases gave high-performance liquid chromatography such scope and versatility that the technique is now a dominant method for separations.

Ion exchangers are natural substances. For example, certain clays or deliberately that synthesised resins, containing positive ions (cation exchangers) or negative ions (anion exchangers), that exchange with those ions in solution that have a greater affinity for the exchangers. This selective affinity of the solid is called Ion, or cation Exchange Chromatography (IEC). The first such chromatographic separations were reported in 1938 by T.I. Taylor and Harold C. Urey, who used a zeolite. The method received much attention in 1942 during the Manhattan Project as a means of separating the rare earths and trans-uranium elements, fission products of uranium and other elements produced by thermonuclear explosions. Ion-exchange chromatography can be applied to organic ion separations and is of special importance for the separation of amino and nucleic acids.

The solubility of solids in gases at high pressure had been observed as early as 1879. In 1958, the British scientist James Lovelock suggested that gases above their critical temperature (i.e., the temperature above which a liquid phase cannot be produced by increasing the pressure) might be

used at high pressure as mobile phases. A substance in this state is termed a supercritical-fluid. At very high pressure, the density of the fluid can be 90 per cent or more of the liquid density. The German chemist Ernst Klesper and his colleagues, working at the Johns Hopkins University, were the first to report the separation of the porphyrins with dense gases in 1962. Carbon dioxide at 400 atmospheres (one atmosphere equals 760 millimetres or 29.92 inches of mercury; standard sea-level pressure is one atmosphere) is a typical supercritical fluid mobile phase. In an extreme case, Giddings and his groups used gases at pressures of up to 2,000 atmospheres to chromatograph carotenoids, sugars, nucleosides, amino acids and polymers. Supercritical fluid chromatography brings a gap between gas chromatography and liquid chromatography. In a gas chromatography concentration of solutes in the gas phase is achieved with increased temperature. Supercritical-fluid chromatography achieves this result with increased pressure so that thermally unstable compounds may be analysed. Additional advantages include increased speed and resolution.

A technique exhibiting great selectivity, affinity chromatography, was first described by Pedro Cuatrecasas and his co-workers in 1968. In these

separations, a biomolecule such as an enzyme binds to a substrate attached to the solid phase while other components are eluted. The retained molecule can subsequently be eluted by changing the chemical conditions of the separation.

Another separation technique is based on the fact that the velocity of a fluid through a tube is not uniform. In the region immediately adjacent to the wall the fluid is nearly stationary. At distances farther from the wall, velocity increases, reaching the maximum value at the centre of the channel. In 1966, Giddings conceived the idea that a field, electrical or gravitational, might be used to selectively attract particles to the wall, where they will move slowly through the system. Diffusion, away from the high concentrations at the wall, into faster inner streams would enhance migration. The net effect would yield differential migration. A thermal gradient between two walls has also been used. This recently developed technique is called field-flow fractionation. It has been termed one-phase chromatography because there is no stationary phase. Its main applications are to polymers and particulate matter. One phase chromatography has been used to separate biological cells, sub-cellular particles, viruses, liposomes, protein aggregates, fly ash, colloids and pigments.

# LIVING WITH ARTHRITIS

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Arthritis, known as common cause of disability affects almost one person in every family and actually refers to a group of over 100 different conditions. Osteoarthritis and Rheumatoid Arthritis (RA) are two commonest types of the diseases. These are not only found in humans but also throughout the animal kingdom. Some skeletons of prehistoric animals displayed in museums show signs of an arthritic condition. It is estimated that about one per cent of the global population suffers from one or the other types of arthritis affecting some of the 264 synovial joints present in the human system. Arthritis is the name given to a disease involving principally the joints and is characterised by pain, stiffness, swelling and finally loss of function. In this disease the lining of the joints gets inflamed and can result in damage to its surface. The exact reason why the disease occurs is not known. Patients of arthritis may become so incapacitated that they are unable to perform even the most routine tasks. This incapacity combined with pain and deformity caused by disease and with enforced idleness and dependency often results in a sense of hopelessness and depression.

Osteoarthritis is the most common form of arthritis. Many factors which predispose the joint to osteoarthritic changes have been identified. These include ageing, wear and tear, mechanical

derangement in joint, obesity, haemophilia, crystal deposition, genetic and environmental. It is an insidious, slowly advancing joint disorder commonly found in middle-aged and elderly individuals characterised by destruction of articular cartilage, overgrowth at joint margins and joint deformity which produce variable clinical disability of an affected joint. It is not wholly due to ageing of cartilage but represents a disequilibrium and disorganization of the process of degeneration and repair. Osteoarthritis is called primary when no known predisposing factor is present. Secondary osteoarthritis is differentiated from primary in that there is a clearly defined underlying condition such as trauma, metabolic disease or inflammatory arthritis contributing to its cause.

Some of the changes which occur at joint during genesis of arthritis are now well-recognised. Degeneration of articular cartilage is the hallmark of osteoarthritis. Degeneration involves softening of cartilage due to loss of mucopolysaccharide ground substance "chondroitin sulphate". Superficial layers of cartilage, often not always in areas of stress become fragmented and fibrillated. With joint motion, this fibrillated cartilage is lost thereby exposing underlying bone. With the loss of full thickness of articular cartilage, characteristic changes take place in the

underlying bone, i.e., subchondral bone. The denuded bone is now exposed to the erosive action of opposing joint surfaces. The exposed bone becomes thickened in response to increased stress and frictional effects of joint motions which also produce a polishing effect giving a smooth ivory-like appearance to the bony surface. This is known as 'eburnation'. The progressive loss of cartilage is often associated with proliferation of new bone and cartilage at the joint margins, resulting in spur formation. These series of changes cause remodeling of bone. The clinical presentation of osteoarthritis can be divided into early and late stages. The early stages are dominated by pain on motion and stiffness, night pain and responsiveness to anti-inflammatory medication. The pain is an early symptom and results from distortion of joint capsule plus inflammatory infiltration of the capsular tissues and direct pressure upon exposed subchondral bone. Initial stiffness is probably the consequence of two roughened cartilage bearing surfaces moving one on another. The late stages are dominated by joint instability, predominance of pain at rest accentuated on weight bearing, and failure of responsiveness to anti-inflammatory agents. As this condition progresses, limitation of movement increases often more in one particular direction than another, resulting in fixed deformity. It becomes difficult to sleep on the affected side. Gait disturbance of variable severity can also be observed.

Rheumatoid Arthritis (RA) is the other commonest type of arthritis. It is a result of interaction of different set of factors. Although the disease is not genetically inherited, some inherited molecules on the surface of cells increase the likelihood of one getting the disease.

The disease is not contagious but a viral or bacterial infection can act as a trigger to start the disease process in susceptible individuals. Once the process is triggered off, antibodies and immune cells that are defend against infection, turn against the body's own tissues and damage it. The brunt of the damage is borne by joints. Rheumatoid Arthritis that starts before the age of 16 years is called juvenile rheumatoid arthritis. Women are more likely to get the disease as compared to men. Since the type of arthritis that occurs in RA may resemble the arthritis of several diseases, it may take a while before the diagnosis is settled. Most individuals with RA have an antibody called rheumatoid factor. It is important to realize that this is not found in every patient with RA and that it can occur in a small percentage of normal individuals and also patients with some other diseases.

The diagnosis of arthritis is made on the basis of clinical presentation, X-rays and some blood tests. However, none of the conventional techniques for diagnosis of arthritis conclusively tells about the progression of the disease. Options such as CT and MRI scan will yield comprehensive information, but these diagnostic procedures are too expensive to be used routinely. Radionuclide imaging of the affected joint can yield information with respect to the extent of damage caused to the cartilage and bone by the intruding synovium. Painful joints are treated by non-surgical and surgical procedures. Non-surgical procedures include rest, physiotherapy, reduction in body weight, use of ambulatory aids and medicines. Rest is needed if the inflammation in joint is severe. However, if too much rest is given the joint may become stiff and muscles around them become weak. With a right balance between rest

and exercise, most patients can lead an active life. Ambulatory aids such as stick, walker or crutch avoid full weight bearing on the concerned joint and helps to alleviate symptoms of arthritis. In addition, use of shoe-raise to compensate for true or apparent shortening improves the gait of arthritic patients. Immobilisation with the joint with traction in the acute inflammatory phase of arthritic process reduces strain on the joint. Utilisation of appropriate splints and braces are also recommended for the patients. Battery of analgesic/anti-inflammatory/anti-pyretic medicines are recommended for getting relief. These medicines slow down the progress of disease by their lysosomal-stabilising and anti-prostaglandin effects on the articular cartilage. Some of them bring about immunosuppression, immunostimulation, immunomodulation decrease pain and swelling and improve joint mobility. Slow active anti-rheumatic drugs or anti-rheumatic drugs act at a more basic level in the pathway that leads to disease and do not start working soon after they are administered. They act slowly taking from weeks to up to six months or so for their beneficial effects to appear. But none of them arrest the progression of disease. The treatment is economical but prolonged usage and frequent dose adjustments are required. Long term use of drugs is associated with side-effects. Recently, several new medicines including monoclonal anti-bodies are being tried in patients with advance disease. In general, three indicators for considering a surgical procedure include progressive and irreversible loss of joint functions, pain especially nocturnal pain and diminishing capacity to carry out activities of daily living independently. Surgical procedures include arthrodesis, arthroplasty, osteotomy, patellectomy

and total joint replacement. But the post-operative problems of immobilisation such as deep vein thrombosis, chest infection, urinary stasis and pressure source are constant source of worry when surgical treatment of weight bearing joint is undertaken.

Radiation synovectomy offers a viable and attractive alternative to surgical procedures for the effective management of arthritis. It involves intra-articular injection of a beta-emitting radionuclide of appropriate nuclear, chemical and biochemical characteristics, into the affected synovial joint to control the excessive proliferation of synoviocytes. For example, yttrium 90 for knee joint or rhenium 186 for shoulder, elbow, wrist and hip joint and erbium 169 for small joints such as metacarpophalangeal joint or tarsal joints. The mechanism of action is by beta-emission which destroys the infected hypertrophied synovium causing shrinkage of synovium thereby improving the painful condition and restricted movement of the joint. However, the radiation exposure to healthy organs due to radionuclide escaping from injected joint cavity was a matter of concern. The current approach is to make the particles of appropriate size and then label them with the radionuclide of choice thereby reducing their probability of escape from cavity. Development of colloidal particles such as silicates, citrates and hydroxyoxides of the isotope  $^{90}\text{Y}$  and  $^{169}\text{Er}$  has reduced the incidence of leakage from the joint.

Thanks to the modern research in the field of nuclear medicine for developing the new procedure called 'radiation synovectomy' for removing the inflamed lining of the joint without conventional surgery. Conventional surgery is expensive, needs hospitalisation and involves long

convalescent period. Radiation synovectomy is cheap and does not require any indoor admission. It has many other advantages over surgical procedures, e.g., it is a minor intervention, possible in inoperable patients, without side-effects, simultaneous treatment of multiple joints is feasible or at short intervals and repetition is possible. Contradictions are children, pregnancy, destruction of articular cartilage and severe malrotation of knee joint. Radiation synovectomy is invasive and relief generally lasts for three to four years. In case of recurrence, the treatment can be repeated. The radiopharmaceutical division of BARC has taken up a programme for development of radio-synovectomy agents. The radio-isotopes of choice are the ones which can be easily produced in large quantities in medium

flux reactor, e.g. Holmium 166. This isotope is prepared at Dhruva reactor and made available to large number of patients at reasonable rate. The biological evaluation of labeled Holmium hydroxy-apatite particles [ $^{166}\text{Ho}$ -HA] was done at Radiation Medicine Centre at Ruby Hall Clinic, Pune. Earlier, this centre has been practicing radiation synovectomy using imported products. The centre has demonstrated that the product from Dhruva reactor could be used as replacement for the expensive commercial synovectomy agents. The indigenous availability of this product for radiation synovectomy would be an important milestone and make this treatment more widely available at affordable cost to the needy patients of India. This product is earmarked for regular deployment on a large scale through the Board of Radiation and Isotope Technology (BRIT).

# 'HEAR' IT LOUD AND CLEAR

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Loss of hearing is one of the largest yet least defined ailments in India. Statistics show that one out of every 12 persons in this country is affected by this problem to some degree. Yet we pay less attention to hearing loss. Perhaps, this is because hearing loss is invisible and painless. In fact, those who are deaf suffer from devastating emotional, social and psychological pain. Hearing loss is India's least understood problem because it is a hurt that does not show. Among the infirm and defective, the deaf mutes are most short-lived as they suffer in silence, are less expressive and the least understood. Today, there are many unsolved problems related to hearing and balance disorders, and there are indications that the size of the problem is growing. Though the opportunities to do something about these problems today are better than ever before, the many unsolved mysteries of hearing and balance disorders still persist. Poor hearing disrupts communication among people. Most important among them is between teachers and students and father or mother and children. It leads to falling grades, isolation and unhappiness among learners. Hearing loss among olds leads to strained tempers and irritability. Aged persons should take degeneration of ears sportingly and get

their hearing tested with the help of audiometry tests after which suitable hearing aid can be used. Emotional stress which accompanies hearing loss in children, young ones and elderly can be reduced through awareness, motivation, rehabilitation and planning.

First of all one must have preliminary information of the ear structure and functioning. The master communication organ, the ear has three parts, the external ear, the middle ear and the internal ear. The external ear comprises of pinna and canal which conducts sound waves to tympanic membrane. This membrane separates the external ear from middle ear. The vibrations of this membrane facilitate process of hearing. The middle ear is an air-filled cavity which contains three small ossicles and two muscles. Eustachian tube opens in middle ear, by one end and its other end opens in pharynx. The internal ear or labyrinth consists of Cochlea, vestibule and semicircular canals. Cochlea is a coiled bony tube like shell of a snail. Sense organ of hearing is lodged here. Organs of static balance are present within vestibule and kinetic balance within the semicircular canals.

If you are suffering from deafness, a complete otological examination by a ear specialist is



necessary to find out the type of hearing impairment, its probable cause and recommended treatment. Today, it is possible to detect deafness in infants as old as a day. This is done by a process called Auditory Brain stem Response (ABR), a computerised system whereby the patient doesn't even need to speak or answer. Deafness is mainly of two types, conductive deafness and sensorineural deafness. School-going children mainly suffer from glue ear. In this condition, the middle ear fills up with fluid, which becomes thick like glue, the eardrum cannot move and hearing is reduced. In some cases glue is surgically removed from the ears by putting small ventilation tube in the eardrum. The other common ear problem in children is the entry of an animated or inanimate foreign body in the ear canal/tunnel. Objects such as beads, grains, broken pencils can be intentionally inserted into the ear. Like-wise, small living insects also enter the ear. These foreign bodies are removed with the help of hook or forceps. Childhood memories remind us of mother's protective words 'Don't forget to wash behind your ears'. But have you ever wondered why 'clean behind' and not 'clean your ears'? According to Dr. Morwani, President, All India Association of Oto-Rhino-Laryngologists, 'Never use cotton buds'. If you must, do so only under medical supervision. It isn't necessary to clean one's ears. The ear has a self-cleaning mechanism. It secretes a solution that lubricates and keeps the inner walls healthy and moist. Ear wax isn't just debris that's piled up in ears, like dirt on a neck or knee or elbow. There are valid reasons for making wax by the ears. The ear canal is a narrow tunnel and about 2000 little glands stud its outer walls. These glands are known as cerumen glands. They secrete yellow wax-like oily

secretion. Why do ears make this oil? The skin covering the canal is very thin and dries out easily. Ear wax coats fragile skin thereby offers protection. Furthermore, (i) It also acts as water repellent, helping shower and pool water to run back out the way it came; (ii) It traps in dirt and dust before it makes its way farther into the ear; (iii) It even acts like fly paper, trapping tiny bugs before they can crawl back into ears; and (iv) It has an ingredient that kills germs, helping protect ears from infection. The secretions of cerumen and sebaceous glands on getting mixed form a lump or blackish mass in the external ear. This sometimes causes pain. However, this can be removed. If the wax is hard, it can be softened by ear drops and then removed. Being fragile, skin of the ear canal becomes inflamed if you have scratched your ear or if you have a skin condition such as dermatitis or eczema. Infection of the ear canal skin (otitis external) may lead to conductive deafness.

Common ear problems which hinder hearing include: ear discharge, ageing, antibiotics, tinnitus and vertigo.

**Ear discharge:** Most people tend to brush off ear discharge as unimportant. The fact is any discharge from ear signifies an infection which has set in and calls for immediate action. The middle ear is connected to the back of nose through eustachian tube which serve as a pressure equalising valve for the ear. Due to this link infection from upper part of the nose can spread to middle ear. During cough and cold, phlegm travels through the eustachian tube and causes an infection in the middle ear. The eardrum of an infected ear may rupture

resulting in perforation. With proper treatment from specialist at this stage, infection of middle ear usually subsides and perforation heals. However, if a child does not get proper treatment at this stage, the infection spreads and perforation fails to heal and hearing loss occurs with intermittent or constant discharge. Untreated infection which often afflict infants and children under the age of ten generally leads to hearing loss and thereby delaying the learning process. Researchers have found that susceptibility of a child to getting infections in the middle ear, depends on genetic make up which he/she has inherited from his/her parents. Being aware of a possible family susceptibility to otitis media (middle ear infection) can help parents and paediatricians to diagnose and protect their children. The following steps should be taken to control ear discharge:

- Keep the ear canal clean by means of a small cotton tipped applicator.
- Use the medication as prescribed by the expert.
- Avoid blowing your nose. This prevent infection in your nose from spreading to the ear.
- If perforation is present, you should not allow water to get into canal. This may be avoided by placing cotton in the external ear canal while taking a shower or washing hair.
- If you desire to swim, use tight fitting swimming cap.

**Ageing:** Progressive dealing in hearing sensitivity due to ageing process is called presbycusis. Hearing loss affects majority of people above the age of 45 and their hearing gradually gets deteriorated as a part of the ageing process. According to reliable estimates approximately 30 per cent of senior citizens have a significant hearing loss that adversely affects their receptive

communicative ability. Presbycusis is more than simple loss of hearing. It is a complex disorder involving loss of speech processing and discrimination as well as perception of sounds of different frequencies. Rehabilitation measures of aged include: (i) Careful explanation of the problem. (ii) Reassurance to the patient that he is not going to be deaf. (iii) Amplification of sound with a suitable hearing aid. Changes in the hearing, due to ageing nerve, causes a decline in hearing sensitivity. Speech is audible but not clearly discernable to the listener. Hearing aid is a boon to such a patient. For finding out 'suitable hearing aid frequency' hearing should be tested with the help of audiometry tests. A thorough hearing aid evaluation sometimes involves more than one session. Clear explanation regarding limitations of hearing aid and strong motivation to encourage the patient to use the aid are mandatory if patient is to receive the full benefits of amplification. Hearing aid user should keep in mind the following facts:

- Using hearing aid requires physical and psycho-acoustic adjustments which take time.
- For every hearing aid user, the role of family friends and co-workers is crucial, especially during initial period of adjustment to the hearing aid.
- Never buy hearing aids off the counter. Specific aids are prescribed for specific causes, depending upon the severity of your ear problem.
- Cheap aids could cause more distortions of sound. Beware especially of Rs 500 hearing aids liberally dispensed over medical counters. Good hearing aids cost from Rs 8000/- upward. Some even cost Rs 70,000. India makes good quality hearing aids.

- If a well tested, good quality hearing aid is of no use to you then look for a Cochlear implant.

**Antibiotic-induced hearing loss:** Common antibiotic called amino glycosides impair hearing. Many bacterial infections that are resistant to other drugs respond best to this group of antibiotic. It is estimated that ten per cent of all those admitted to hospital receive aminoglycosides. However, recent research suggests that hearing loss associated with this antibiotic can be curtailed by taking aspirin along with this antibiotic. But, before beginning daily aspirin use, check with your physician. Doctors remind us that there can be significant risk for some people in taking the aspirin. By thinning blood, aspirin can retard clotting and cause excessive bleeding. So regular use of aspirin may not be appropriate for people with bleeding disorders.

**Tinnitus:** It is the perception of sound without any outside auditory stimulus. This sound is often described as a ringing but it can vary in pitch and take the form of buzzing, roaring, clicking or a number of other sounds. It can be constant or intermittent, loud or soft. When it is constant, it is annoying and distracting. Tinnitus is the result of damage to the microscopic endings of the hearing nerve. The cause of tinnitus varies from person to person. Most often tinnitus results from exposure to loud sound. Tinnitus can also accompany thyroid hormone imbalance, whiplash, head injury, Meniere's disease, allergy, high or low blood pressure, diabetes, tumours and vascular diseases. Drugs, that is, certain antibiotics, sedatives and antidepressants trigger this condition. Most people are able to largely ignore tinnitus. But some are not able to filter out these

extraneous sounds and are severely bothered by them.

If your ENT specialist finds a specific cause of your tinnitus, he may be able to eliminate the noise. But this determination may require extensive testing, including X-rays, balance tests and laboratory work. The treatment of tinnitus includes:

- The most common treatment to address tinnitus directly is referred to as a sound therapy. This approach uses some form of externally generated sound to mask or distract the sufferer phantom tinnitus sounds.
- Tinnitus retraining therapy: In this treatment, the patient is trained to perceive tinnitus sounds as insignificant and filter them out of conscious thought, much as routinely filter out repetitive environmental background noises. This therapy requires lengthy training sessions conducted over a period of 12-18 months.
- A drug that reduces tinnitus significantly is lidocaine. But it has to be given intravenously. Furthermore, it can trigger disturbances in heart rhythm. Due to these reasons, despite lidocaine's anti-tinnitus potentials, it has not become practical option for managing this condition.

**Vertigo:** The inability to orient the body in relation to surrounding objects is medically called vertigo. Knowledge of the position of one's body in space and its relationship to surrounding objects is achieved by a process of continuous and largely unconscious sensory perception. Orientation of body in space is controlled by a complicated system which includes, eyes and eye muscles, inner ear, central coordination system

and different fibres from joint muscles. Five sensory modalities which control our bodily position and motions include: vision, vestibular sensation, joint position sense, touch-pressure sensation and hearing. This multichannel input is rapidly integrated by central nervous system. Organs of equilibrium present in inner ear are vital in detecting changes in the position of head. Vertigo which is a disturbance in the orient detecting system of a subject manifest itself as intermittent dizziness, fluctuating hearing loss, aural pressure, whirling sensation. Spell of vertigo may lead to momentary loss of consciousness and falling of patient to ground who tries to regain his position by holding nearby subjects. After the spell of vertigo is over sense of unsteadiness makes the patient afraid to move. Common cause of vertigo include dilation of vestibular apparatus in inner ear due to accumulation of endolymph, head injury, organic brain damage involving vestibular nerve, its end organ or connections of cerebellum and drug toxicity. Doctors recommend Chair test, Cochleaography and Electro nystagmo graphy for the evaluation of vertigo. However, vertigo remains an etiological and therapeutic enigma. Various ways to contain its symptoms include a low salt diet, cessation of smoking and calcium blockers. Surgery is an option but surgical procedures involve the risk of hearing loss and facial nerve paralysis. Vestibula-sedative drugs, e.g., medicine or diazepam and antiemetic drugs can be taken on the advice of doctor.

If the deafness is due to the problem in the internal ear, it is called cochlear/sensory or inner ear deafness. When deafness becomes sensorineural you need Cochlear implant. This implant produces hearing in a deaf child or adult who cannot use a hearing aid. Vast majority of

candidates for this implant are congenitally deaf. In these patients, hearing aids are ineffective because the mechanism by which sound is converted into electrical signals in cochlea is absent. Deafness during childhood can be devastating as it hinders speech development. Inadequate sensory inputs during this period can lead to life-long communication defects. That's why cochlear implant is a must for children. Electrical impulses produced by ear implant could stimulate brain regions in children born deaf and help them to hear and speak, provided that implant is placed in inner ear within few years of child's birth. Age seems to be the most important determinant for successful outcome of these implants. Ideally, a decision to implant should be made before the age of two, but this requires most efficient nonmetal hearing screening programmes. No child should be considered too young or too disabled for Cochlear implant. In some cases Cochlear implant can be carried out even in elderly persons. The biological safety of this implant has been established but is a costly procedure. The assessment, surgery, implant and spare parts, medication, hospital expenses, therapy plus one year post-operative care costs about 2-3 lakh rupees.

Epic Biosonics, the Canadian Company has developed the first totally implantable bionic ear, which promises to revolutionise life for the deaf. The device, operated by a battery with one millionth power of domestic light bulb, is small enough to go inside the ear of a newborn baby, allowing the hearing part of the brain to develop. At the heart of bionic ear is a speech processing chip, which orchestrates sounds and sends them to the brain. It is water resistant and requires minimal surgery to install.

# THE WATER DECADE 1981–1990

## Iain Guest

Ask someone from an affluent city suburb to characterise water and you would probably get a curious stare and something along the lines of “colourless, tasteless and abundant.” But ask the same question to a villager in the Third World, and the answer might well provide a web of insights into a life of extraordinary hardship. For here water does not come from the ubiquitous tap. It has to be carried—usually by women—from a well or a river up to a mile away, several times a day. It is usually insufficient, and what there is may be so badly contaminated that it risks causing severe diarrhoea.

The fact that safe drinking water and its corollary, proper sanitation, are taken for granted in the more affluent countries but are a matter of life and death in the developing world has been monitored with increasing concern by WHO in recent years. This concern expressed itself in the UN agencies’ own way of generating a sense of political urgency—the large international conference.

The Habitat Conference, held in Vancouver in 1976, stated as a goal —“fresh water for all by 1990.” The UN Water Conference at Mar del Plata, Argentina, in 1977, made this more specific and designated the period 1981-1990 as the International Water Supply and Sanitation Decade, while 1978-1980 would be the years for collecting data and evaluating the dimension of the crisis.

Thirdly, the 1978 Alma-Ata Conference on Primary Health Care spelt out in broad outline some of the ways and means of incorporating the decade into a new two-part strategy for health: more “relevant” health services, and more emphasis on preventive health with all-round social and economic development.

Sanitation is closely related to drinking water indeed the rows of defecating children that are a common sight in much of the Third World are a more dramatic reminder of the problem than the absence of fresh water. Several studies have stressed that providing only safe drinking water or only facilities for disposing of excreta without the other half of the solution will be unlikely to lead to an improvement.

How serious is the crisis? WHO carries out regular surveys on the coverage of community water supply and excreta disposal services in the developing countries. The most recent, published in 1975, found some 1,230- million people without adequate water supply and 1,350 million without sanitation. More specifically, by the end of 1975 the total population of the developing world, excluding China, was roughly 2,000 million people; of these, 70 per cent lived in the rural areas and the rest in cities. While 57 per cent of the city population had access to community water through house connections, and another 21

per cent through public standposts, in the rural areas only 22 per cent had access. A total of 38 per cent of the Third World's population had access to safe drinking water.

In the cities, 25 per cent of the population had house connections to sewerage systems and an additional 50 per cent were served by household systems. In the rural areas, only 15 per cent had any access to sanitary latrines. Of the total number of people estimated to be without these most essential of services, more than 700 million are children—an important and alarming figure, particularly as 1979 has been designated International Year of the Child.

The first consequence of the lack is disease, WHO estimates that as much as 80 per cent of all disease in the world is associated with water. It can take several forms. Firstly, there are germs ingested through drinking contaminated water: these cause typhoid, gastro-enteritis and cholera. Then, communicable diseases such as scabies and trachoma, transmission of which is favoured by chronic water shortage or poor quality of water. Thirdly, disease caused by parasites that inhabit water and burrow through the skin—like schistosomiasis, which is carried by snails, or dracunculiasis, carried by the guinea worm. Finally there are the carriers (vectors) of disease which breed in bodies of water. The most serious of these are mosquitos, responsible for the current alarming upsurge of malaria, and the flies which cause river blindness (onchocerciasis).

In round figures an astonishing number of people suffer from these water-related diseases at anyone time: 400 million with gastroenteritis, 160 million with malaria, 30 million with river blindness, 200 million with schistosomiasis.

This connection between the lack of clean, piped water and disease is now well established. In one case, in a cholera outbreak in the Mulange district of Malawi, the families who escaped the disease were those with piped water which, though untreated, was coming from upstream and was therefore uncontaminated. Those who suffered were those without piped water.

WHO surveys have noted another characteristic of fresh water - it comes with money. One 1970 survey found that in countries with a per capita income of less than US \$ 110 a year, over 80 per cent of the population still lacked excreta disposal services and fresh water. For most countries with incomes within the range of \$ 110 and \$ 1000 the proportion is considerably smaller and ranges from 20 to 70 per cent.

Within countries, the disparity in services between urban and rural areas is often accounted for by the higher income of town dwellers, and their ability to apply greater political pressure in order to get services. Slums, however, stand out as an important exception, particularly since they are expected to expand dramatically in the next 14 years.

In a limited sense the situation is improving. WHO's 1975 mid-decade survey showed that the number of urban dwellers survived by drinking water had increased from 316 million in 1970 to 450 million in 1975 from 67 to 77 per cent. In rural areas the increase was from 182 million to 313 million—14 to 22 per cent. For excreta disposal, the increase was from 71 to 75 per cent in urban areas and from 11 to 15 per cent in the countryside. But this is still far below rate of increase called for by the International Decade. In



addition, the UN Fund for Population Activities (UNFPA) estimates that, irrespective of the success of family planning, the world's population is certain to double by the end of the century.

Furthermore, bare statistics can be falsely optimistic or may mask deficiencies. No water system can be entirely leak proof, even in an advanced industrialised country. Where water can leak contamination can enter. In a survey of 401 cities in the United States, two researchers found that in one out of ten cities, 25 per cent of the water were being lost. As with food lost during storage from rodents, water lost from leaky pipes in the developing world can amount to as much as 50 per cent.

The water supply is often intermittent. This is serious, because when the pressure falls off there is no resistance to the intrusion of pollutants from the outside. An estimated 27 per cent of the water supplies in Africa, south of the Sahara are intermittent and as much as 91 per cent of the water supplies in South-East Asia. Again many cities employ two systems of water—one safe for drinking and the other for washing streets and watering gardens. When they run side by side, there is a serious risk of contamination.

The 1981-1990 water decade concerns only safe drinking water and sanitation. It does not directly concern water management, which was discussed during the Desertification Conference held in



Plentiful supplies of clean water save lives, particularly among babies, as well as making life easier for women

Nairobi in 1977, nor the challenge of increasing and mobilizing water resources so as to meet food requirements. But clearly, all are interconnected, and it will be one of the aims of the decade to stress this.

Malnutrition and a lack of fresh water are inter-related. Malnutrition undermines the individual's resistance to such diseases as diarrhoea. Diarrhoea itself further reduces the intake on food and causes loss of body fluids, resulting in further malnutrition. Just as the need of food is greatest in the developing countries so is the need for water: in a dry climate the body requires, on average, up to twice as much water (5 litres) a day.

The Mar del Plata Conference in Argentina called for an unparalleled effort to be made by governments and the international community—a call that was reiterated by last year's WHO/UNICEF Conference on Primary Health Care held at Alma-Ata in Soviet Kazakhstan. In a joint report to the Conference, the heads of the two agencies noted that "Plentiful supplies of clean water help to decrease mortality and morbidity, in particular among infants and children, as well as making life easier for women. Countrywide plans are required to bring urban and rural water supplies within easy reach of the majority in the shortest possible time."

That conference ended with 22 recommendations and the Declaration of Alma-Ata. In broad terms, these said that the best form of preventive health care is social and economic development. They stressed the need for increased investment, and underlined that the form of technology and manpower to be involved must be relevant to the needs and resources of the countries involved.

Of course, this is more easily said than done, as with all conferences clarion-calls. What are the obstacles? In 1970, 88 countries were asked precisely this question in a WHO survey. The replies were illuminating; 48 gave lack of internal finances as the first problem; 10 cited the lack of external resources, 11 said they lacked a proper administrative structure, and said the chief concern was the lack of trained personnel. It is not hard to see why money looms so large. Between 1970 and 1975 the amount invested on water throughout the world were on average \$ 67 per person in urban areas and \$ 17 in rural areas.

The World Bank and WHO reported to the Mar del Plata Conference that \$ 1,40,000 million would be needed to reach the target of "clean water for all by 1990." For this to be achieved, investment on water supplies in urban areas would have to be increased one and-a-half times and in rural areas four times, while eight times as much would have to be spent on sanitation.

Where will it come from? On past performance, from the countries themselves. External aid from donors in the industrialised world has been falling behind the two targets set by the UN: one per cent of all net flows, or 0.7 per cent of the GNP for official development assistance. In 1970, net aid from the 17 Western member-countries of the Development Assistance Committee (DAC) was \$ 17,400 million instead of the target of \$ 22,000 million. Of the money invested on water in 1971, only 12 per cent in urban areas was met by aid and nine per cent in rural areas. In the same year, \$ 710 million of aid went to community water and \$ 142million to sanitation. But even these figures disguise the fact that more than half the aid went



to Latin America, and only two per cent to South-East Asia, where the need is even greater.

It is not, of course, simply a question of money. It is a question of political will and priorities. The Alma-Ata Declaration talks of the need to involve the community—almost a catch—phrase by now, but essential if the water decade targets are to be met. Community development starts with the family. Since women are usually the carriers of water, and often control the family's, hygiene and health, they are the first obvious target. In Kenya, for instance, the Women's Associations are actively promoting basic family health and sanitation. Third World mothers cope marvelously well with their family health in trying circumstances, but they probably need to be told about the benefits of fresh water and sanitation. They may not be aware that diarrhoea (which, according to the 1975 World Bank report, was the leading identifiable cause of death in Paraguay, Guatemala and El Salvador) can be cured by administering a simple sugar and salt solution to replace lost body fluids, and that there is no need for expensive drip treatment in hospitals. Again, people may have to be encouraged to act together to construct a simple tube well pump, since the only pumps in operation may have been owned by rich farmers.

"Community development" implies appropriate tools or technology—another catchphrase. But the acid test of technology is whether villagers will in fact use it. Well-meaning aid programmes have introduced latrines into villages only to find that they are not used, because they are malodorous, have to be emptied are uncomfortable to use, and draw public attention to a bodily function which many prefer to perform at night.

The British development agency OXFAM has designated a latrine currently in use in Viet Nam as one of the best available in the Third World. It cuts down disease, and also turns human excreta into organic manure, producing some 6,00,000 tons a year. After 45 days, when the excreta have been rendered bacteria free, it can be removed from a hole in the back of the latrine. In the Republic of Korea, human excreta are turned into methane gas, for use in 50,000 rural households.

One reason why the community should be involved from the earliest time in decision making is the problem of maintaining pumps and latrines. These services, in fact, again raise the dilemma—who should pay? WHO's policy is in general that the communities should share the costs, partly in order to increase their sense of responsibility. And yet, having the poorest pay for the services which should ideally be free seems to be a contradiction.

This problem had to be overcome in one of UNICEF's most successful programmes—to install tube wells in Bangladesh a country where more than 60 per cent of all disease is caused by polluted water. Bangladesh is peculiarly vulnerable. It is washed by three huge rivers and in the monsoons 70 per cent of the country lies under water. Too much water means flooding, yet too little means drought. And because the country is so flat, there is no possibility of preserving the water for use in the dry season.

## **Changing Priorities**

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In most countries at the most senior level the government—it is not so much a question of the amount of money as a question of priorities. Even though the benefits stemming from having a healthy population are now well established, it is as difficult

for a government to direct sanitation and water services towards the poor as it is to change health priorities from city-based hospitals to rural health centres. Their difficulties may increase if government economists regard such services as “pouring good money after bad”, and suspect that “community development” is another way of saying they will have no further control over how the money is used.

Then there are the problems of administration. Whose responsibility is water—that of the health ministry or of agriculture, or of a separate department? If water is going to be shared by several ministries, there will clearly be problems of coordination. But if it is going to be under a separate administration, other concerned ministries may well argue that they should no longer be involved. Yet most countries which have rated water and sanitation a priority are setting up separate administrative systems.

One fact stands out: where governments have committed themselves to the objectives of the Water Decade, particularly with the active collaboration of village communities, improvements have been substantial. In the Dominican Republic in 1961, 43 per cent of the urban, and 83 per cent of the rural population lacked safe drinking water. The government set up a National Drinking Water Institute and the situation began to improve. “There was no single factor involved,” says one WHO official, “It had a proper institutional structure; proper training of staff; built-in flexibility: cooperation between ministries and coordination of resources; tight technical supervision; dynamic community organisation.”

Similarly, Brazil has created a national sanitation plan and the National Housing Bank has been given the task of providing funds. The target is to provide 80 per cent of running water for the urban population by 1980.

In the old crowded streets of Ibadan, Nigeria, a “family group” of between 100 and 1,000 people makes an application to the Ibadan sewerage authority, and undertakes to provide land, labour, and running costs. The government then constructs “conform stations”, with one toilet and shower for every 25 people.

But governments by themselves can not be expected to carry the burden of increased investment. Part of the contribution to the Water Decade from international agencies will take the form of greater coordination. With WHO and the UN Development Programme taking the lead, collaborative action will involve the World Bank, UNICEF, the Food and Agriculture Organisation, the UN and the ILO. This in turn will seek to mobilise external cooperation for the Decade from bilateral and multilateral agencies. Within each country the UNDP resident representative will coordinate the needs. Each agency will continue to perform its special function, but the net results will be a much greater degree of coordination.

One other important form of cooperation was recommended by the Mar del Plata Conference, and that was regional cooperation. This will take the form of strengthening the water commissions in the various regional UN economic commissions, and also making greater efforts to share common water.

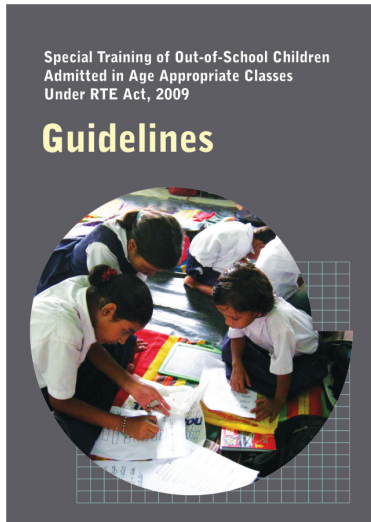
Whether such sharing actually happens could determine whether governments have the will to

make the Water Decade a reality. Countries downstream argue that they are at the mercy of those upstream, which can turn valuable water on and off at will (by closing dam sluices), or may cause pollution and contamination which is beyond their control. Countries upstream argue that they cannot be constrained by considerations outside their own

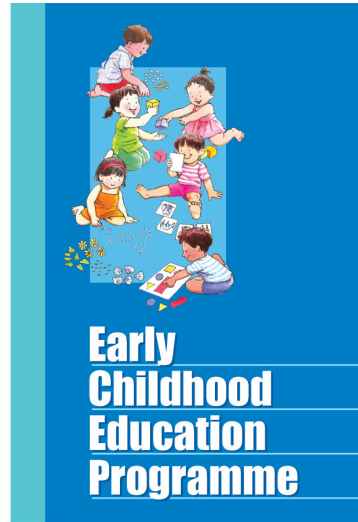
frontiers. Agreements such as that between Bangladesh and India over the Farraka Dam across the Ganges or between Brazil and Paraguay over the Parana River, suggest that international cooperation is indeed possible.

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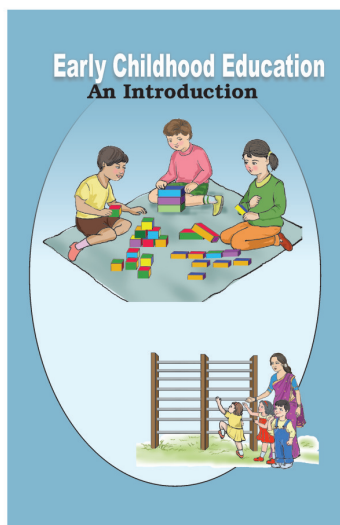
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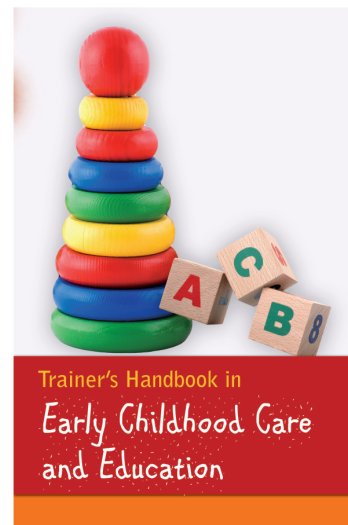
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